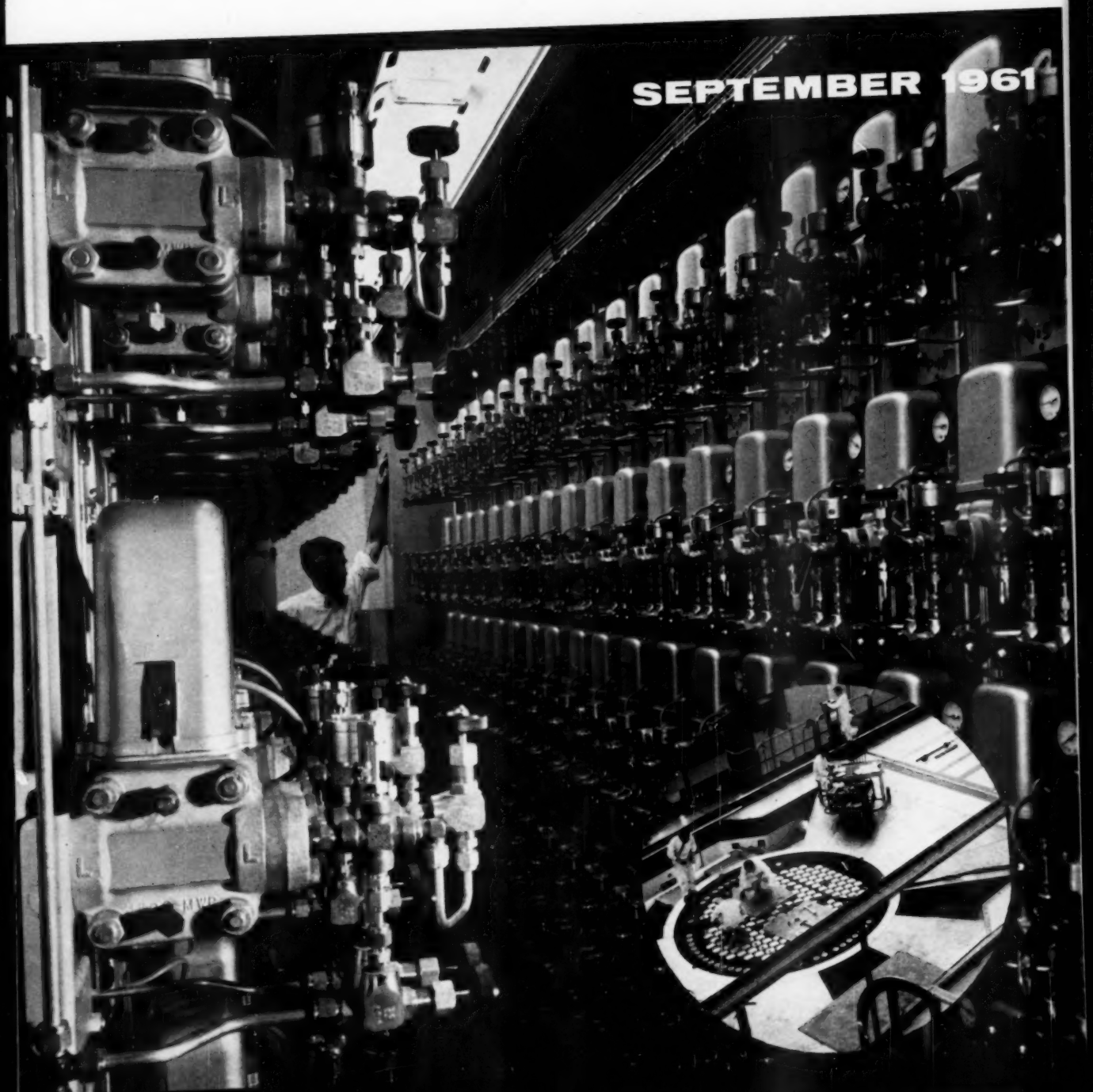
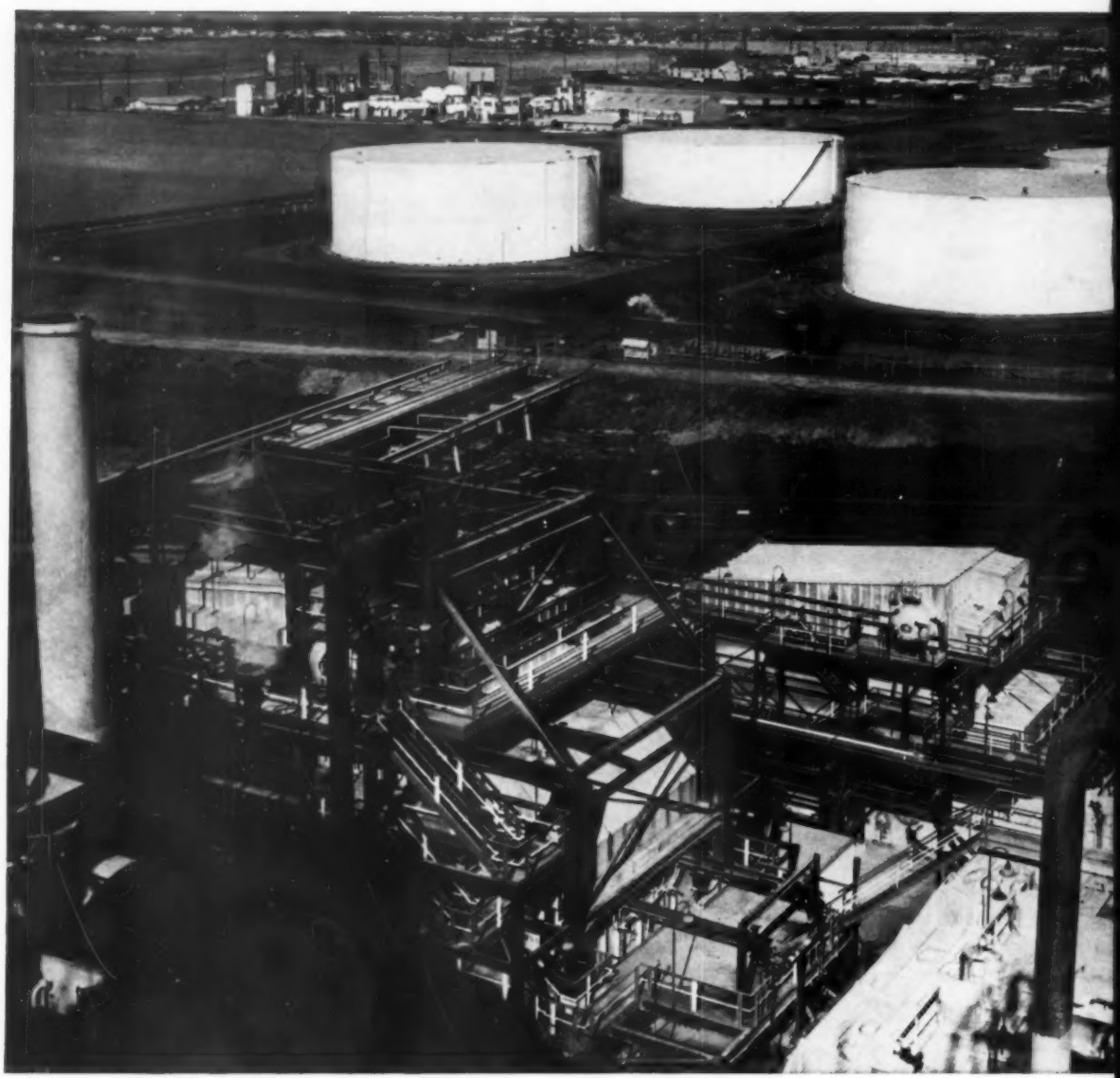
Power Engineering®

SEPTEMBER 1961



NUCLEAR PLANT INSTRUMENTS AND CONTROLS



At Richfield Refinery, B&W boiler "team" provides

dependable operation with maximun

Two highly efficient B&W boilers of entirely different designs — system engineered into a money saving "team" — are providing operating flexibility and dependability at Richfield's Wilmington, California refinery.

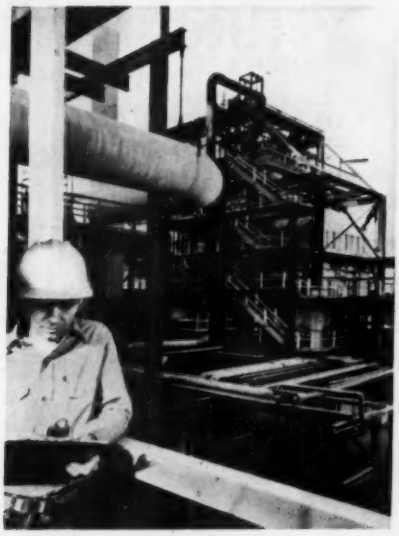
The two boilers are the CO* Boiler, which operates on waste gases from the refinery process, and the PFI, which burns refinery gas, natural gas, or oil with equal ease.

The CO Boiler has been base loaded at 340,000 lbs./hr. full load since its installation in 1954, with an availability exceeding 96%. Developed and pioneered by B&W, the CO Boiler improves refinery economy by burning cat-cracker gas that would otherwise be wasted. The Richfield unit is typical of the many CO Boilers that have solved air pollution problems.

Supplementing the steam produced by the CO Boiler, the PFI boiler is equipped to use the lowest cost auxiliary fuel, whether oil or gas, at all times.

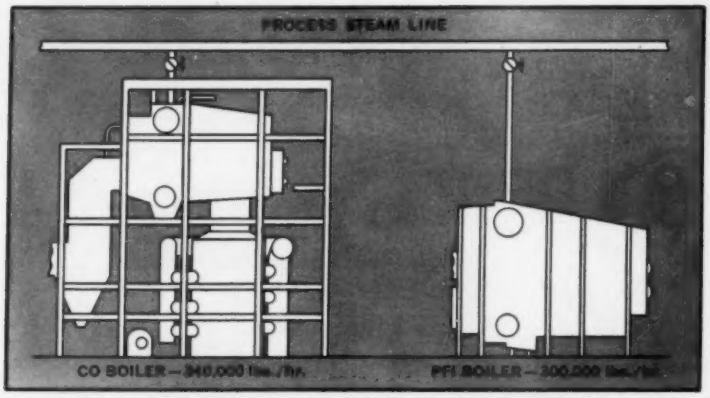
*Reg. U.S. Pat. Off.

AXIMUM AVAILABILITY — No unsched-ed outages have occurred since the CO oiler (left) and the PFI boiler (right) ent on the line. This complete freedom om unscheduled shutdowns plus sus-ined high efficiency provides Richfield ith dependable steam at 640,000 lbs./hr.



PAYS FOR ITSELF—Burning cat-cracker gas that would other-wise go up the stack and pol-lute the atmosphere, the B&W CO Boiler cuts operating costs to the extent that it, and others like it, pay for themselves in fuel savings in less than 3 years.

FLEXIBILITY OF OPERATION — The PFI boiler helps keep steam generation costs down by providing immediately all needed steam in excess of that which can be obtained by burn-ing the waste gas.



EASY TO OPERATE, INTEGRATED CONTROL CENTER—Fully automated control center equipped with Bailey meters ties this boiler "team" together as a dependable source of low cost steam to meet refinery requirements.

fuel savings

This compact, versatile boiler, designed for 300,000 bs./hr supplies steam required in excess of that roduced from the waste gases, and responds mmediately to changing conditions.

By continually developing more efficient and conomical ways to generate steam, B&W has elped many industries to meet growing steam emands at lowest possible cost. For further details, ontact The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

G-990-1B

B&W

THE BABCOCK & WILCOX COMPANY

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Here's a vertical turbine with

TERRY SOLID WHEEL

and all its advantages

When it comes to judging a turbine's ability to deliver in vertical service, ratings tell only half the story. It's the Terry construction refinements that give you assurance of long-range operational economy: Thrust bearing designed to absorb external pump thrusts ... carbon ring glands specially made for vertical operation ... casings and bearing housings split vertically for easy accessibility.

But most important, the Terry vertical turbine has an *almost* indestructible rotor. A single forging of special composition steel, it has no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

If your application demands a vertical turbine, specify Terry solid wheel. Available in capacities from 5 to 300 horsepower. And remember, the extra durability built into these vertical turbines is typical of every turbine in the complete Terry line.

For further information, send for a copy of bulletin S-137.

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Comment

Each year, Power Engineering presents a special issue on "Changing Shapes in the Power Field." These have roundups of particular facets of our industry, and all material has come from recognized and authoritative sources. Such subjects as Automation, Peaking Power, and Exotic Power Sources have appeared in the last few years. Next month we give you Changing Shapes in Transmission and Distribution, authored by some of the top experts in the field. Don't miss it!

Bob McCaw

EDITOR

BPA

NBP

Complete editorial index

ON THE COVER

An idea of the instrument and control complex in a nuclear plant is gained from this Chalk River Nuclear Research Center photo. Here, some of the 200 differential pressure transmitters provide an interesting frame for the reactor core. See A. Dahlinger's article on page 56. (Photo courtesy of The Foxboro Co., Ltd.)

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around the power circuit

Brain of transistorized supervisory system is this plug-in logic element. Made by GE, it remotely controls power transmission for Western Massachusetts Electric Company

PIONEERING New England paper company with almost a century of tradition behind it is making plans to use atomic power in its production of paper. Fitchburg Paper Co. of Fitchburg, Mass., whose corporate roots extend back to the kerosene lamp days of 1864, has applied to the Atomic Energy Commission to participate in a demonstration low-temperature process steam generating project incorporating a nuclear reactor. A low-temperature process heat reactor is one designed to fit the needs of industrial operations such as those in paper manufacturing, where large amounts of heat are required.

UTILITY INDUSTRY'S first solid-state supervisory systems have been installed at Western Massachusetts Electric Co. Installation of two solid-state systems, made by GE, herald completely automatic power transmission for the entire Pittsfield, Mass., area. Remote operation of three substations will be accomplished with solid-state master control unit located at one substation in Pittsfield.

Solid-state remote control eliminates manual operation and visual checks of line equipment. Small computer-designed plug-in cards operate the entire system from a control station.

TWO NEW generating units at Southern California Edison Co.'s Huntington Beach Steam Station are now in full operation, making it the largest single power source on the Edison system. With completion of the fourth unit, rated at 225,000 kw, the station now has a total generating capacity of 870,000 kw. Units 3 and 4 are fully automated.

JERSEY CENTRAL Power and Light Co. has filed with the Federal Power Commission a declaration of intention covering the Yards Creek pumped storage hydroelectric project. Public Service Electric and Gas Co. will participate with Jersey Central in the project, a 300,000-kw capacity power plant in Blairstown Township.

This project is being designed to be compatible with the proposed developments on the Delaware River when and if they are built, and also to comply with the State of New Jersey's present plans for the supply of potable water from the Delaware River when additional diversions become necessary.

Yards Creek would use an upper reservoir atop Kittatinny Mountain and a lower reservoir on Yards Creek, each with a storage capacity of more than 1000 million gallons of water.

AMERICAN ELECTRIC POWER reports that its 450,000-kw Clinch River Plant in Virginia, over a full year's operation, has generated electricity below the heat rate level of 9000 Btu per kwh, probably a world's record.

F. GANO CHANCE Engineering Research Center is in full operation at Centralia, Mo. It centralizes A. B. Chance Co.'s research and product development effort and makes high voltage, short circuit and other testing facilities available to power engineers in utilities, colleges and other manufacturers. Watch for a full report in POWER ENGINEERING.

ROBERT T. PERSON, president of Public Service Co. of Colorado, and James W. Cryder, president of Colorado Central Power Co., have announced that the managements of the two companies have arrived at general terms for a merger. Final arrangements will require several months. The surviving corporation will be the Public Service Co. of Colorado.

ULTRACOMPACT nuclear power plant that could be assembled on earth, transported by rocket, and operated on the moon is described in an Atomic Energy Commission research report now available through the Office of Technical Services, Business and Defense Services Administration, U. S. Department of Commerce, Washington 25, D.C.

A $22-MILLION generating unit will be added to the Georgia Power Co.'s Plant Mitchell near Albany. This 125,000-kw unit will almost

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Anaconda fabricates the finest copper alloy tube, sheet, and heavy plate made for power plant, process industry and marine heat exchangers.

More than that. We also provide Total Service that you can't measure by the foot. Only Anaconda delivers such a wide variety of copper alloys, in sheet, large-size plates and single or duplex tube. Among these are Anaconda exclusives like Everdur®, Ambraloy, and Cupro Nickel, 30%-707, a new, lower-cost, high-strength feedwater heater tube alloy. Total Service also includes the experienced on-the-spot guidance and advice of Anaconda technical representatives to help solve any heat transfer or corrosion problem.

Anaconda satisfies your needs for heat exchanger materials. Why not write for your copy of Publication B-2. This 44-page presentation of our tubes and plates for condensers and heat exchangers details properties and fabrication methods. Address: Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 61-922

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triple the plant's size and generating capacity, and is scheduled to go into service in April 1964.

Georgia Power also has plans to construct the first unit of a new giant steam-electric plant on Lake Sinclair between Milledgeville and Eatonton in Putnam County. Generating capacity of the initial $42-million unit will be 250,000 kw. When the plant is completely developed, its generating capacity will be between 1½ million and 2 million kw.

around the power circuit

ENGINEERING GRADUATES of Illinois Institute of Technology, class of 1961, received an all-time high in average beginning salaries, earning approximately 5 per cent more than their counterparts in 1960. The newly graduated engineer started to work for an average salary of $550 a month, compared with a $525 average the year before. The beginning metallurgical engineer led the salary field this year, earning an average of $590, $70 more than in 1960.

DAYTON Power and Light Co. plans to establish an electronic data processing center, which reportedly will be the first in the utility industry to use magnetic imprinting on customer bills. Among data processing to be performed will be revenue accounting, general accounting and engineering studies.

The million-dollar electronic system will be built around two NCR 315 computers made by National Cash Register Co.

President James M. Stuart says: "Virtually all of our record-keeping procedures will be speeded up and performed more efficiently. This includes the calculation of bills for more than 525,000 electric and gas meters installed throughout the West Central Ohio area."

NUCLEAR POWER CORE, valued at $22 million, for the nation's largest stationary atomic electric generating station, being built by the Consolidated Edison Co. at Indian Point, New York, has achieved its first sustained chain reaction. The test, made at the Babcock & Wilcox atomic energy division laboratory, confirmed all nuclear design and engineering calculations.

The test was a pioneering accomplishment in that it was the first time a full-scale power reactor core using a mixture of thorium and uranium oxides had been taken to criticality.

SOVIET UNION now produces 50 per cent more electric power in one day than it did during the entire year of 1920, according to a Russian periodical's report on the USSR's electrification plans. Russian plans for 1961, according to the same article, include adding 7,800,000 kw to the USSR's electric power capacity.

A collection of eight articles from Soviet publications on "USSR Electric Power" has been translated and made available through the Office of Technical Services, Business and Defense Services Administration; U.S. Department of Commerce, Washington 25, D.C.

REA has approved its largest electrification loan—a loan of $60,225,000 to Hoosier Cooperative Energy, Inc., a federation of 16 REA-financed electric distribution cooperatives in southern Indiana. New construction to be financed by the Indiana loan includes a 198,000-kw steam generating plant, 285 miles of 154-kv line with two related substations, 1267 miles of 69-kv line and 123 distribution substations.

BUREAU OF RECLAMATION reports a decline in identical bids and prices in the reopening of 14 schedules of bids on $1¼ million worth of transmission line materials required by the Bureau.

In the previous bidding, of 108 bids received on 14 schedules of transmission line materials, 70 per cent were identical. In the new bidding, after the earlier bids were rejected and readvertised, only 17 per cent of the bids received were identical. In some schedules, the readvertising resulted in a price drop of as much as 10 per cent.

NEWEST research tractor design from International Harvester Co. pairs a gas turbine engine with a hydrostatic transmission. The company believes this may be the first time the combination has ever been tried in a farm and utility tractor.

Called the HT-340, this machine has no gear shift lever, no throttle, no brake or clutch pedals. It uses neither cooling water nor anti-freeze, and has no transmission gears. Oil consumption is almost nil, and it will operate on virtually any kind of liquid fuel, the company states.

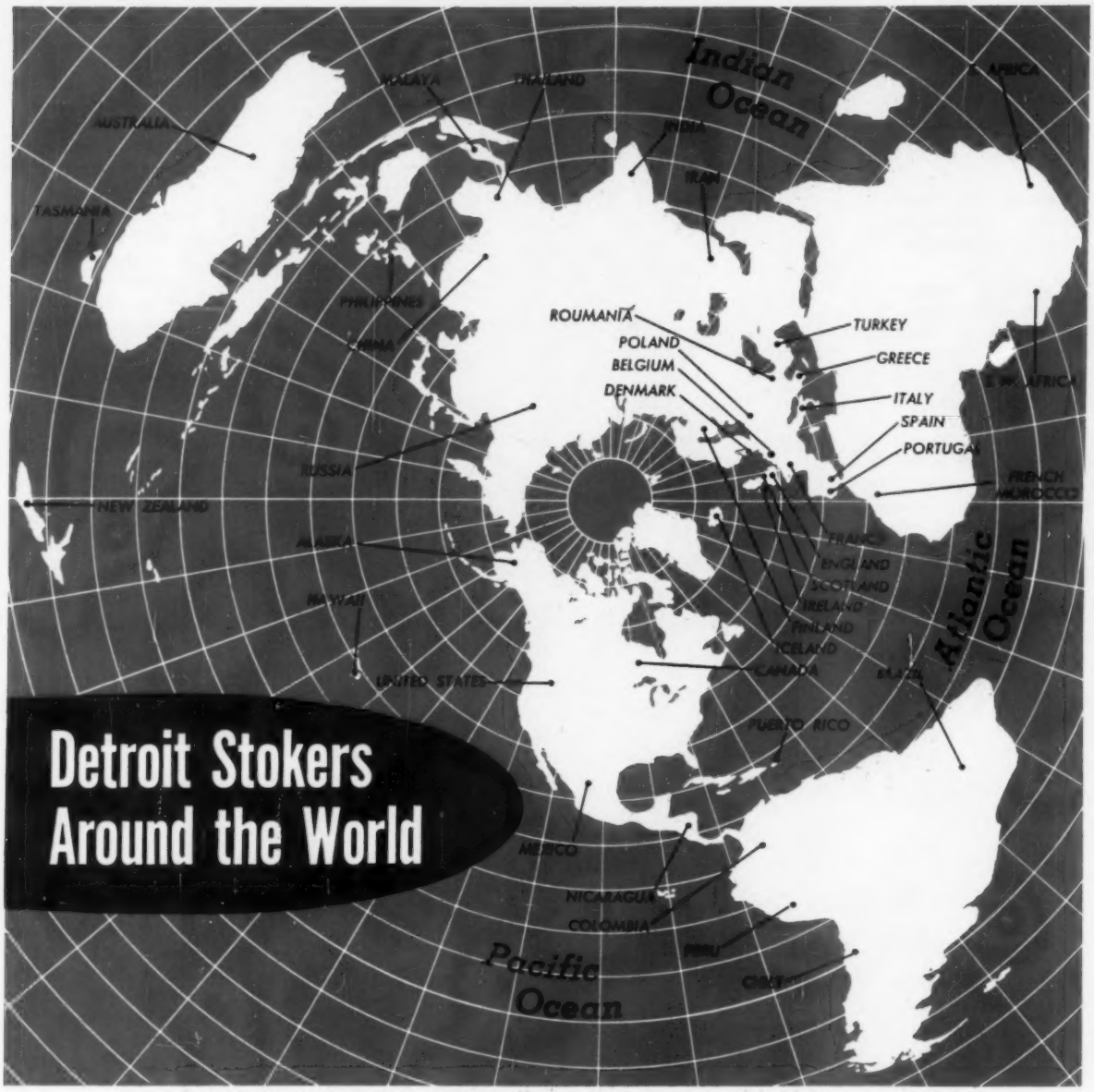
A $4½-MILLION order for a turbine room equipment package to supply power for a Yugoslavian industrial complex has been awarded to the International General Electric Co. The order included a 130,000-kw turbine-generator set, condenser, heaters, turbine-room piping and associated mechanical equipment in the power station, as well as switchgear, transformers and a substation.

WISCONSIN Public Service Corp. will spend $8,014,000 for new construction in the year ending April 30, 1962. Expansion of the electric power transmission system will cost $930,000. Expenditures for new substations and for added substation equipment are estimated to be $566,000. Expanding and improving the electric distribution system will require $2,530,000.

AQUA-CHEM (new name for Cleaver-Brooks Special Products) is out with a new electrodialysis process to convert brackish water to fresh.

According to operating reports, the process, developed by a scientific research organization in the Netherlands, has actual conversion costs of 54 cents per 1000 U.S. gallons at a 2,800,000-gpd brackish water plant for gold mines in southwest Africa. The cost figure is based on a 15-year program for the redemption of capital and accumulation of interest.

Continued on page 92



Detroit Stokers satisfy industrial, institutional and heating needs on every continent of the earth.

Why this universal preference? One important reason. They are engineered for high efficiency, reliability and long life.

There are Detroit underfeed and overthrow spreader types for boiler capacities from 3,000 to 400,000 pounds of steam per hour and for all grades of bituminous coals, lignite and many by-product waste fuels.

Also special designs for municipal and industrial incinerators.

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who

Edward A. Fontaine has been named a vice-president of Stone & Webster Service Co.

August A. Baechle has been appointed executive vice-president of the Electrical Apparatus Service Association. Baechle is a 1957 graduate of Missouri School of Mines and Metallurgy.

Robert Usitalo has been named chief engineer at the University of Detroit. He will be responsible for the operation and maintenance of the power plant which serves the 21 buildings on the McNichols Road campus of the University.

Oliver W. Durrant (below) is manager of a newly created automation and control section in the engineering department of Babcock & Wilcox Co's boiler division.

Gerald L. Phillippe has been elected president, and **Cramer W. LaPierre**, executive vice-president of the General Electric Co. Phillippe has been comptroller and principal financial officer of the company since 1953. LaPierre formerly was vice-president and group executive.

Gerald L. Phillippe

William C. Krutzsch, Jr. has been appointed manager of engineering for Worthington Corp.'s Harrison Division. Krutzsch joined Worthington in 1949. **Leonard J. Wyzalek** has been appointed chief engineer, steam power engineering, at the Harrison Division.

what

Thomas Elmer Moon, an engineer stricken by blindness at the age of 55 and who responded by developing a machine to help transplant corneas and thereby rescue other humans from blindness, will receive the 1961 Holley Medal of ASME.

Joseph C. Swidler, of Nashville, Tenn., former general counsel and secretary of TVA, is the new Federal Power Commission chairman, succeeding **Jerome K. Kuykendall.**

When **Ralph Rowell** of GE's Instrument Dept. received a check from POWER ENGINEERING for his two-part article on wattmeters (April and May issues), the department made a little ceremony out of the event. Left to right are: **M. S. Wilson, Ralph Rowell, A. W. Woodside** presenting check, and **M. H. Bensky.**

Walter J. Seeley, dean of the College of Engineering at Duke University, writes of the article, Electric Power From Gas Jets, by Dr. D. J. Harris in the July issue:

. . . the best I have seen of this type, and I want to commend you for finding such a readable and understandable article on this interesting subject. MHD is talked about very glibly in many circles, with very little fundamentally understood about it by engineers. Dr. Harris has done a commendable job of this and is to be congratulated.

Marvin Gibbons, results engineer at Indian River Power Plant at Millsboro, Del., comments on our series of articles on coal, concluded in the August issue:

I have found your articles, Coal—From Mine to Boiler, to be very informative. Of particular interest to us is the description and sketch of the ram-type unloader.

Want a reprint of these six articles on coal and the power industry? Write the Editor, POWER ENGINEERING.

when

9th annual Joint Engineering Management Conference, Sept. 14-15, Hotel Roosevelt, New York City. Sponsored by ASME, AIEE, ASCE, AIIE, AICHE, AIME, IRE.

AIEE-ASME National Power Conference, Sept. 24-27, St. Francis Hotel, San Francisco.

American Welding Society, national Fall meeting, Sept. 25-27, Hotel Adolphus, Dallas, Texas.

Process Industries Conference, Oct. 4-6, Shamrock Hilton Hotel, Houston, Texas. Sponsored by ASME.

AIEE, IRE, EIA, SMPTE National Electronics Conference, Oct. 9-11, Hotel Sherman, Chicago.

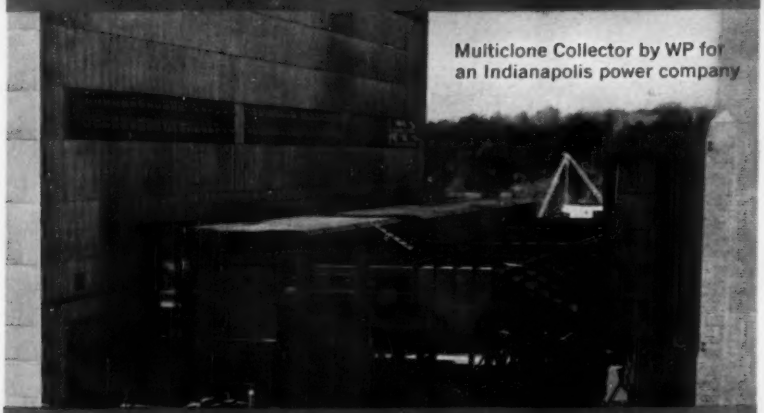
AIEE Fall General Meeting, Oct. 15-20, Statler-Hilton Hotel, Detroit.

October 22 to 28 is the 13th Annual Cleaner Air Week. Sponsor is the Air Pollution Control Assn.

Consulting Engineers Council, semi-annual meeting, Nov. 1-3, Miami Beach, Golden Gate Hotel.

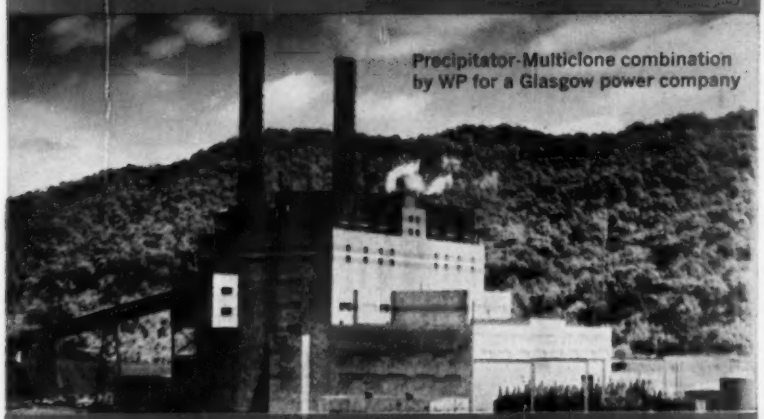
1961 nuclear conference and Atom fair, sponsored by American Nuclear Society and Atomic Industrial Forum, will be held in Chicago, Nov. 6-9, Conrad Hilton Hotel.

National Assn. of Corrosion Engineers, Northeast region, New York City, Oct. 30-Nov. 2; Southeast region, Nov. 27-Dec. 1, Miami, Fla.



Multiclone Collector by WP for an Indianapolis power company

Power plants in Indiana... and West Virginia...agree:



Precipitator-Multiclone combination by WP for a Glasgow power company

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For an efficient, economical solution to any dust control problem—look to Western Precipitation. WP is uniquely fitted to handle your unique problem—being the one organization that custom designs, engineers and installs ALL types of dust and fume control equipment: Precipitator, Mechanical, Jet-Cleaned Filter, Hi-Temp Filter, Scrubbers and engineered combinations.

With no axes to grind for any one system, WP engineers will give your job a completely unbiased recommendation—whether it's a quote on your specifications, a single component, or a completely engineered installation . . . small, major, simple, or complex.

An inquiry—on your business letterhead—will bring you literature promptly. Just write Western Precipitation, 1000 W. 9th St., Los Angeles 54, Calif. (In Canada, write 8285 Mountain Sights Ave., Montreal, P.Q.)

Dust and fume control since 1907

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MULTICLONE Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
THERM-O-FLEX Hi Temp Filters
TURBULAIRE Scrubbers
JOY-MICRODYNE Scrubbers
also: HOLO-FLITE Processors
HI-TURBIANT Heaters
TURBULEX Processors

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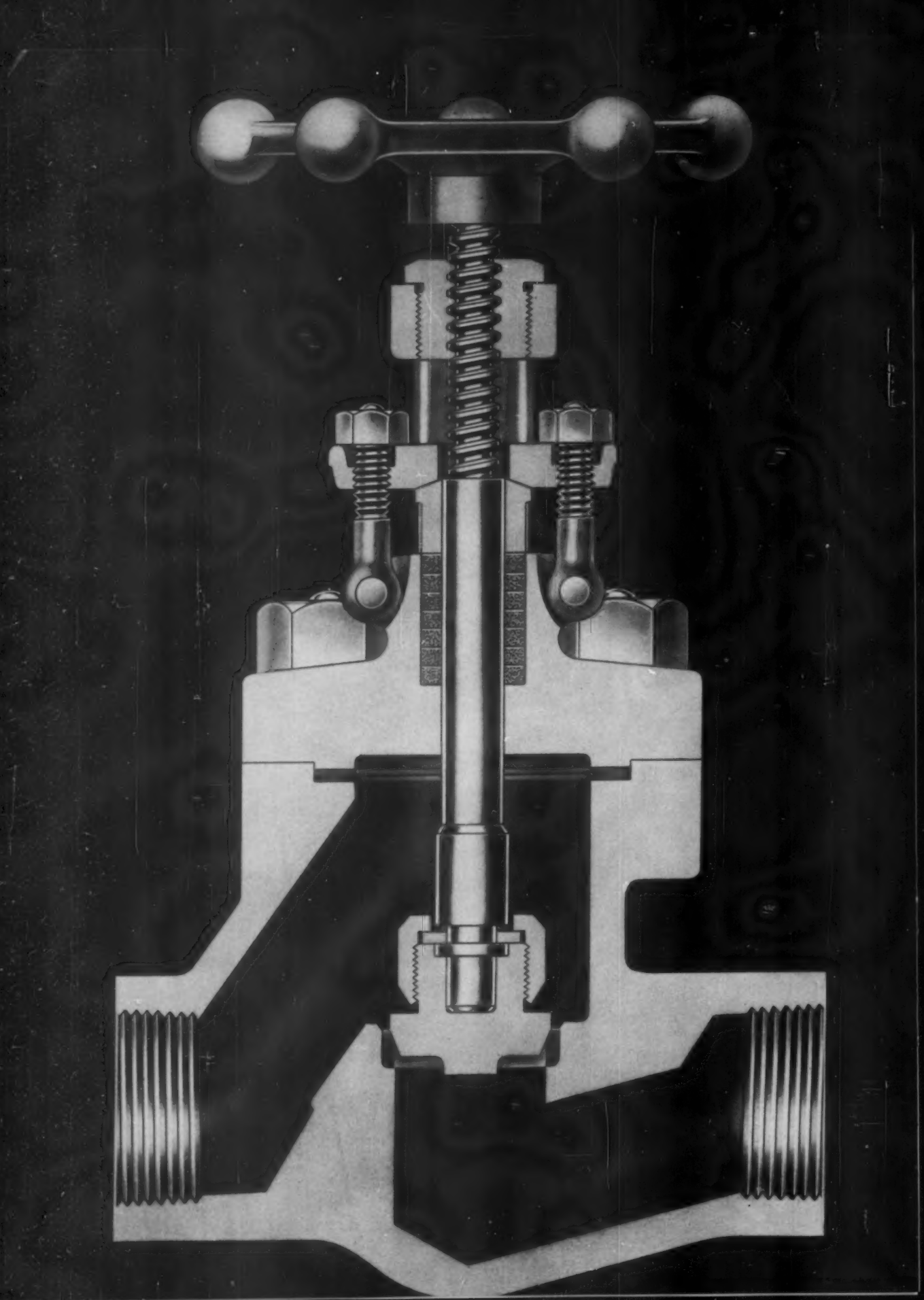

You can tell a quality valve by the attention it doesn't need

A $25.00 valve seldom seems important yet frequently is responsible for the protection of $100,000 of equipment and material . . .

Hancock Steel Valves are especially engineered and produced to operate dependably under unusual conditions of pressure, temperature, and fluid flow. A wide variety in alternate trim, body, and bonnet materials provides for attention-free, economical service in many different industrial and defense applications where downtime can be costly. Hancock Steel Valves have that extra measure of quality that only a leader can incorporate . . . the extra quality needed to protect processes, power generating nuclear systems, and missile launching equipment.

The valve illustrated at the left is the Hancock Type 5500 Steel Globe Valve widely used for all types of industrial plant services.

For technical assistance in selecting quality Hancock Steel Valves, phone your industrial supply distributor or write for Catalog 200A.

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Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
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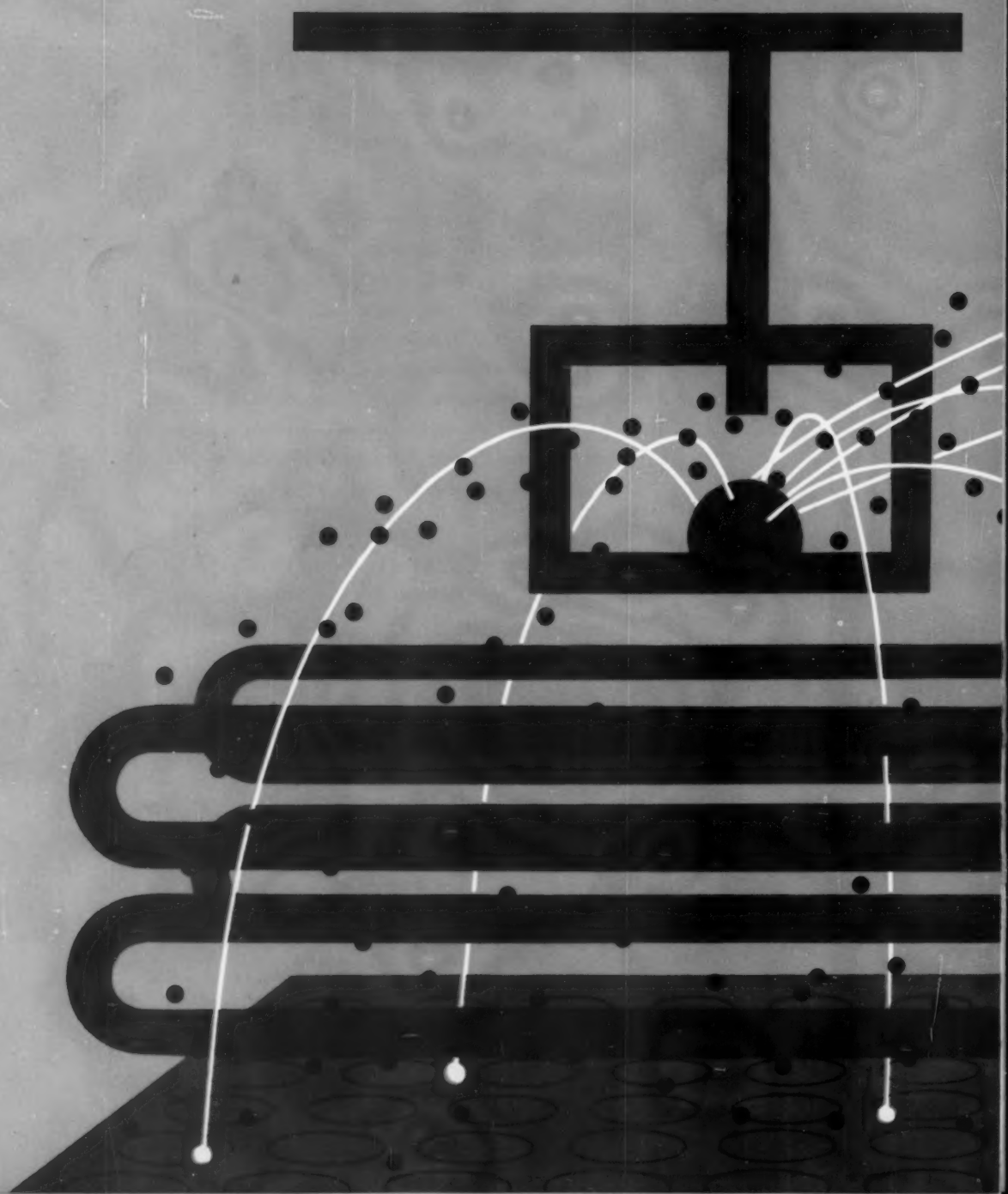
Diamond developed for more economical power...

PENNSYLVANIA ELECTRIC SELECTS DIAMOND SHOT CLEANING FOR AIR HEATERS THAT WON'T STAY CLEAN!



To maintain constantly clean airheaters, thereby minimizing draft losses and reducing annual outage time, Pennsylvania Electric Company is installing Diamond Shot Cleaning Systems on Shawville Station Steam Generating Units No. 1 and 2. Because Diamond Shot Cleaning Systems consistently have proved to be highly effective for this difficult cleaning application, Pennsylvania Electric anticipates significant savings through elimination of unpleasant manual cleaning and the costly boiler downtime that goes with it.

The selection of Diamond Shot Cleaning is typical of Pennsylvania Electric's continuing effort to achieve greater power generating efficiency. It also demonstrates the growing acceptance of a totally new concept in cleaning waste heat, recovery, and power boilers that defy cleaning by conventional methods. At your request, our engineers will be happy to discuss the application of Diamond Shot Cleaning to your new or existing steam generator. Call, write or wire.

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This is the new trademark of Diamond Power . . . a symbol of quality, integrity and progress . . . in products, systems and service.

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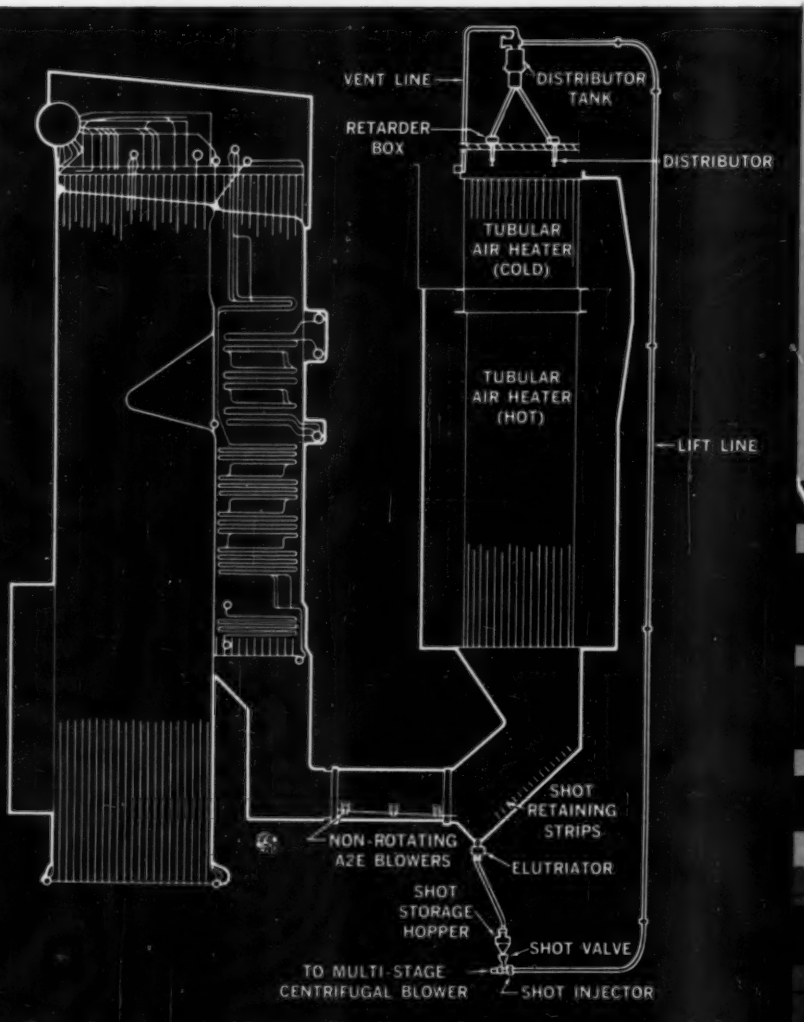
DIAMOND SPECIALTY LIMITED, Windsor, Ontario

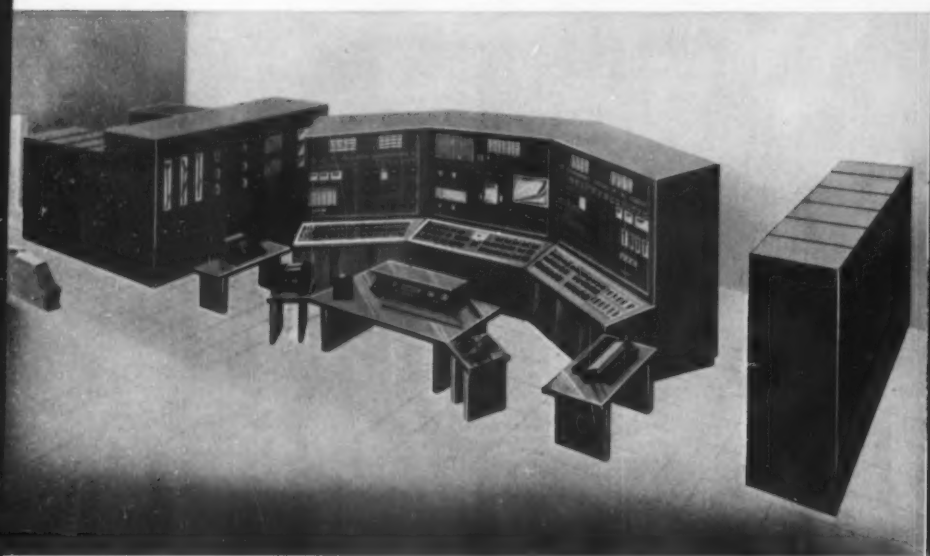


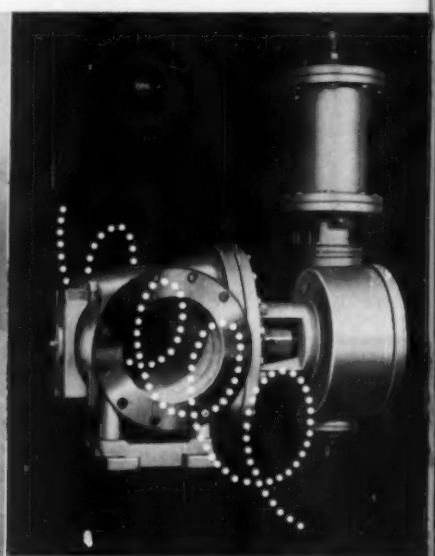
General arrangement of Diamond Shot Cleaning System now being installed on Penna. Electric's Shawville Station Steam Generating Units No. 1 and 2. System has 135 foot lift system . . . highest installation yet using standard equipment.

Current news reports

WHAT'S HAPPENING IN POWER SERVICES?

Highlights: A high voltage control center that requires half as much floor space. Smaller power transformers with considerably more kva capacity. These examples demonstrate the extra value that is standard with Allis-Chalmers . . . the greater efficiency and the added productivity that are yours when you buy A-C products, systems and services. Call your nearby Allis-Chalmers office for details or write Allis-Chalmers, Industries Group, Milwaukee 1, Wisconsin.



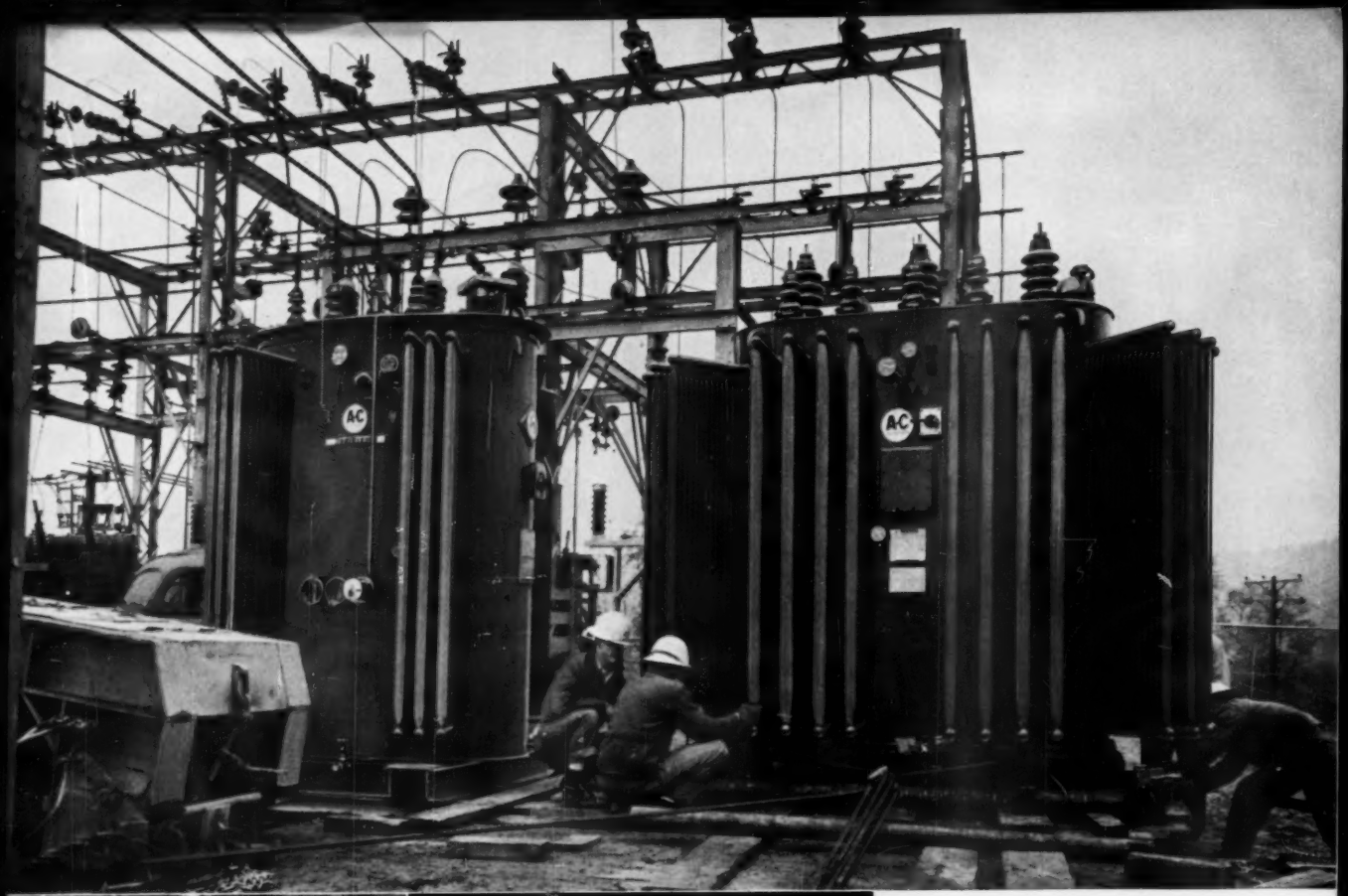


For quality control . . . lower power costs: With the acquisition of Consolidated Systems Corporation last year, Allis-Chalmers extended its ability in the areas of data gathering, handling and utilization. CSC provides such experience acquired from more than 500 successful system projects. Recently, Allis-Chalmers, Consolidated Systems and International Business Machines Corporation effected a nonexclusive mutual agreement relating to the production and marketing of automated control systems.

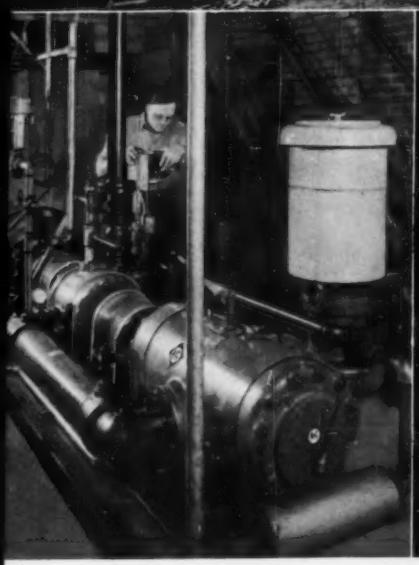
For the typical system, A-C takes functional responsibility for the system using IBM data processing computer equipment, CSC specially engineered data conditioning equipment, instrumentation, and A-C power and industrial processing equipment. Now, Allis-Chalmers brings balance of specialized judgments to bear on your problems . . . drawn on significant experience . . . to make major "contributions to the art" in many phases of *Systemation* and help you be sure before you invest.

"Open road" for unrestricted flow: This *Rotovalve*, when wide open, offers no greater resistance to flow than a straight pipe of equivalent length. Promotes lower pumping costs. Actually seats itself tighter with use. And special shutoff characteristics reduce water hammer. All moving parts are totally enclosed, yet easily accessible.

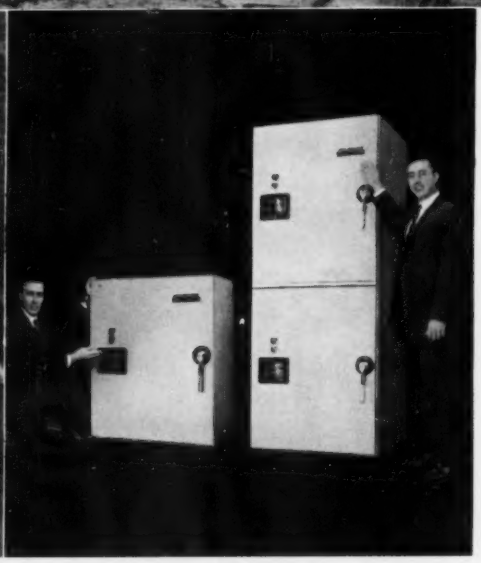
For more data circle 508 on Post Card



Transformers "grow up" but don't get bigger: New Allis-Chalmers transformers deliver as much as a 30% increase in kva without any increase in size or weight. This permits replacement of old transformers without altering base mountings or overhead structures. This unit being installed has twice the rating of the neighboring 3500-kva transformer.



More air . . . less wear, with vibration-free compressors: *Ro-Flo* compressors with sliding-vane rotary design eliminate operating losses inherent in reciprocating machines. Centrifugal force keeps vanes in close contact with cylinder walls, automatically compensating for wear. In addition, fewer moving parts result in less wear, reduced maintenance costs.



So low, two fit where one used to go: This new *SpaceMaker* control center is the first completely new 2- to 5-kv motor controller development in more than a decade. New, compact two-high design can cut floor space requirements in half. Complete draw-out construction makes it the safest, most easily accessible controller on the market. New flame-retardent, track-resistant Super *Pyro-Shield* insulation adds to reliability, reduces size and weight.

A-1522

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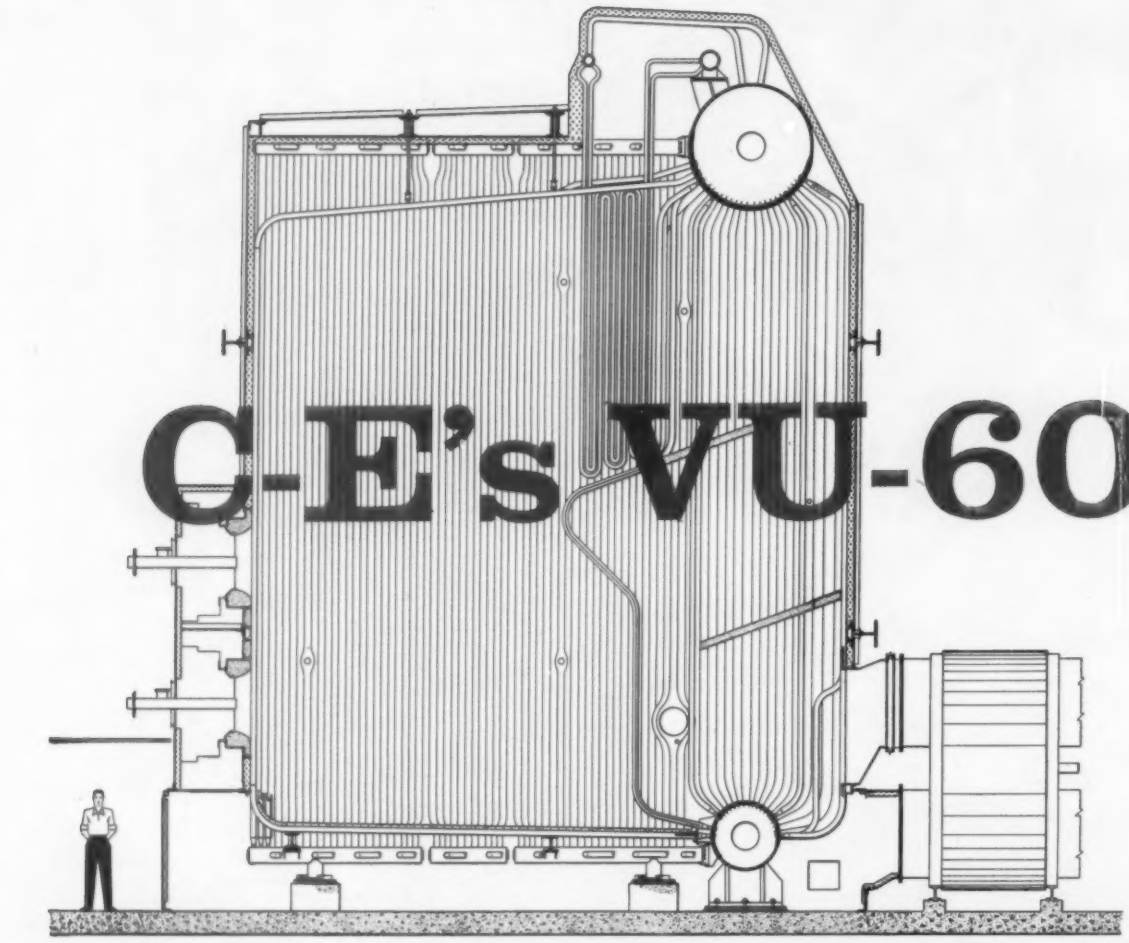
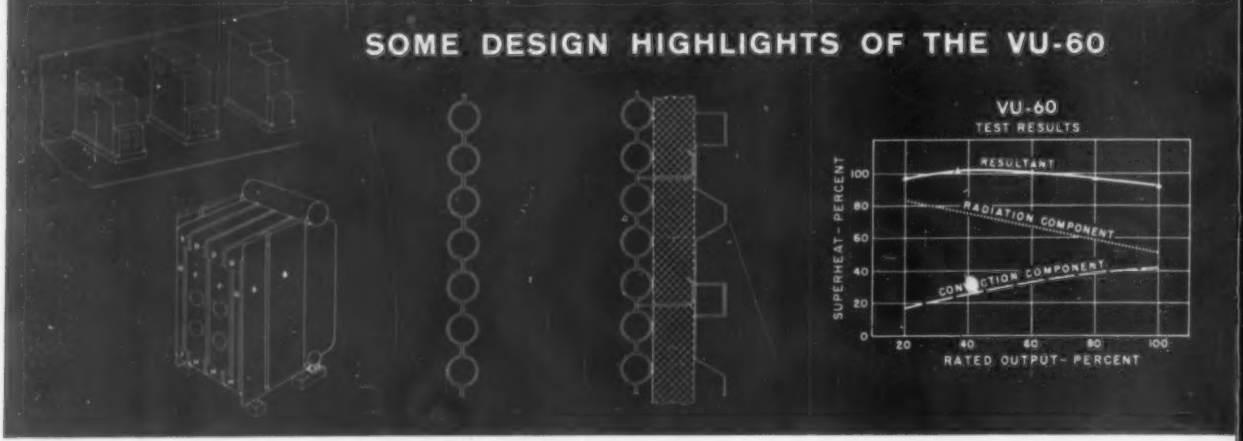
ALLIS-CHALMERS

C-E's VU-60



SOME DESIGN HIGHLIGHTS OF THE VU-60



Modular increments allow assembly of custom designs from standardized components; boiler can be proportioned for best combustion, heat absorption, gas flow — even where space conditions are difficult.

Completely self-cased, the VU-60 is an all-welded pressure-tight envelope composed of modular panels of finned tubes; fewer field welds cut erection time.

Insulation and preformed lagging go directly over tube panels, thus reducing non-working weight per pound of steam generated.

Characteristic of Combustion's VU-60. This superheater curve indicates a temperature stability throughout entire load range.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER

GIVES YOU A CUSTOM-DESIGNED BOILER BASED ON STANDARDIZED MODULAR COMPONENTS

Because of its unique modular concept, C-E's new VU-60 offers unusual flexibility and can be designed to meet unusual or difficult space conditions.

VU-60 SPECIFICATIONS

Capacities:	100,000 to 250,000 lb per hr
Design pressures:	250, 500, 750, 1040 psi
Steam temperatures:	to 900F
Fuels:	Oil and/or gas
Firing:	Horizontal (front wall) or tangential
Size increments:	Depth-twelve Width-eight Height-three
Steam drum sizes:	Four

The VU-60 is a completely self-cased boiler. Finned tubes, shop-welded into modular panels, make up the exterior walls of the unit. The fins joining the panels are field-welded to make a pressure-tight envelope. Insulation is applied directly over these walls and is covered by pre-formed, field-installed metal lagging. The need for bulky or heavy nonworking structural members is kept to a minimum.

The VU-60 can be designed to meet your most exacting steam needs. It is easy to install, economical and dependable in operation, completely accessible and functional. Why not get full information on how this new concept can fulfill your specialized requirements?

COMBUSTION C-E **ENGINEERING**

General Offices: Windsor, Conn., New York Offices: 200 Madison Avenue, New York 16, N. Y.
Canada: Combustion Engineering-Superheater Ltd.

C-322

MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

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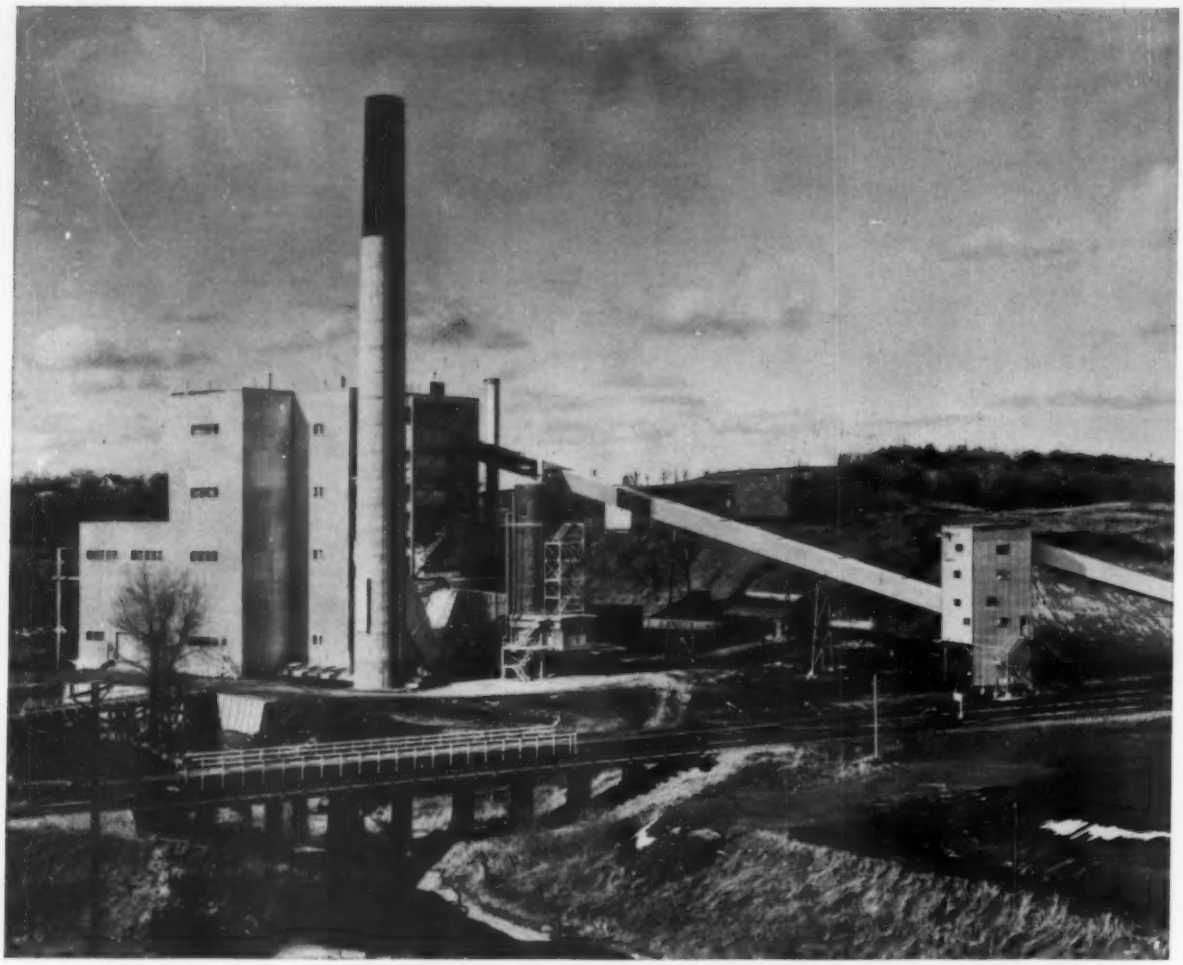


Rated at 53,500 kw, Hoot Lake is Otter Tail's newest station. The Otter Tail Power Company serves a 70,000 square mile area in Minnesota, North and South Dakota. Burns and Roe were consulting engineers.

MINNESOTA UNIT FIRES "WET" COAL

. . . Hoot Lake Station burns 1,000 tons of N.D. lignite daily

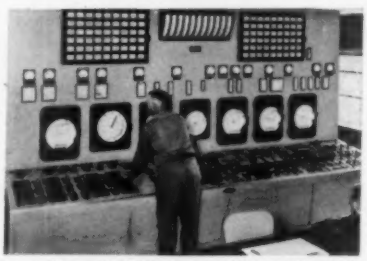
The Otter Tail Power Company's Hoot Lake Station at Fergus Falls, Minnesota, is the largest generating plant in the country burning North Dakota pulverized lignite. The steam generator is the first reheat unit to use lignite as the primary fuel.

Although lignite has a lower initial cost, its high moisture content (30-35%) and low heating value present unusual control problems.

After a year's operation, management is very satisfied with Hagan performance, particularly during several unscheduled outages, when the controls remained on automatic with excellent results. Hagan systems on the unit include combustion, 3-element drum-level, feed-pump, deaerating heater, forced, and induced draft fan control systems.

"Reasons for the selection of Hagan controls," one company official noted, "include satisfactory performance at our other stations, plus the high level of service and instruction provided by Hagan's Regional Service Engineer. We are pleased to have this same proficiency at our Hoot Lake Station."

Look to Hagan for sensible, workmanlike solutions to either special control problems or standard installations. A letter or phone call will put a Hagan engineer to work on your particular problem.



Control Panel at Hoot Lake. Hagan Ring Balance meters and the compact operating console make it easy for a single operator to maintain close control of the operation.

HAGAN
CHEMICALS & CONTROLS, INC.
HAGAN CENTER, PITTSBURGH 30, PA.

HAGAN DIVISIONS: CALGON CO. • HALL LABORATORIES • BRUNER CORP.

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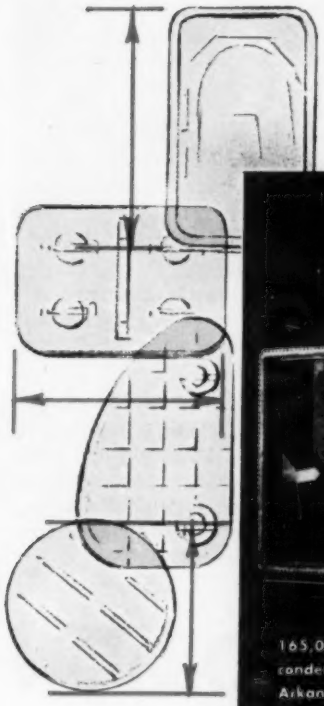
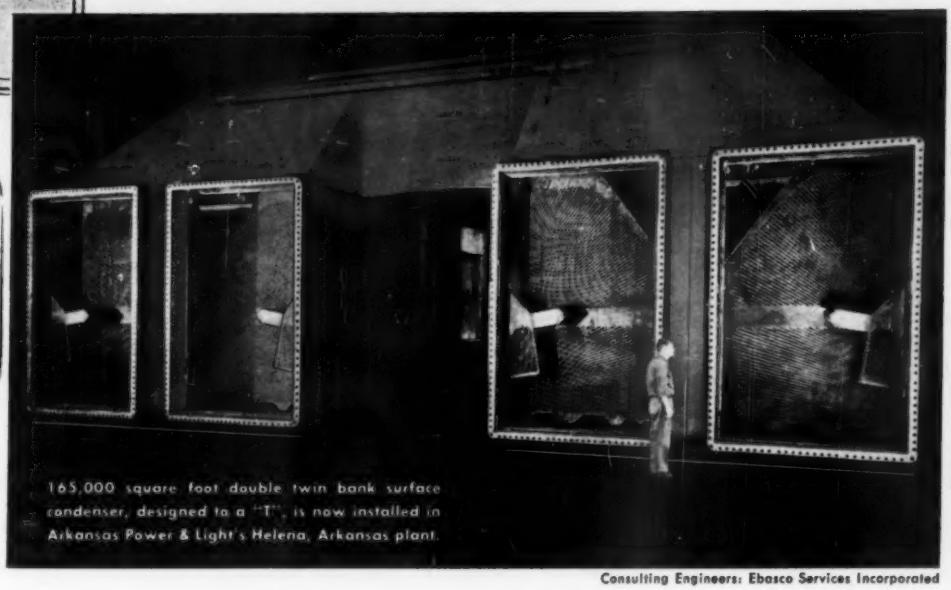


YUBA CONDENSERS
ANY SIZE . . . ANY ARRANGEMENT



165,000 square foot double twin bank surface condenser, designed to a "T", is now installed in Arkansas Power & Light's Helena, Arkansas plant.

Consulting Engineers: Ebasco Services Incorporated

MOST VERSATILE TUBE BANK LAYOUT IN THE INDUSTRY

YUBA SURFACE CONDENSER DESIGN . . . most flexible...any size...any arrangement. Through design advances such as those incorporated in the unit above, Yuba illustrates the concepts you can expect from years of engineering leadership in the power industry.

Yuba's twin-bank tube layout, seen here in a two shell "T" type installation, promotes unobstructed, equally distributed flow. Through Yuba's patented design, the condensate can be deaerated with oxygen content guaranteed to be less than 0.005 cc per liter.

As a design extra, Yuba staggers the tube support plates – reducing harmonics – eliminating vibration. These are some of the reasons why Yuba surface condensers of all sizes have been installed in plants throughout the world. You'll want to know more about the most versatile tube bank layout in the industry – contact Yuba today.

Other Yuba products for steam power plants include feedwater heaters, evaporators, expansion joints, cranes, tanks, structural steel erection, and scores of other items.

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YUBA HEAT TRANSFER CORPORATION
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Sales Offices in Principal Cities

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HELPFUL WATER CONDITIONING DATA FROM BETZ

RETURN LINE CORROSION

Causes of corrosion can be readily identified and economically corrected.

Corrosion in the condensate return lines of boiler systems is a frequent problem. To properly prescribe a solution to the difficulty, it is necessary to determine the primary cause of the attack. Prompt elimination of serious return line corrosion is certainly most advisable since necessary maintenance and replacement of pipe and fittings can be quite costly.

By far the most common causes for return line corrosion are the presence of either oxygen or carbon dioxide, or both of these gases dissolved in the condensate. The appearance of the corroded sections will be a good indication of the cause. An attack by carbon dioxide will be characterized by an actual thinning of the metal wall of the pipe, with associated grooving of the metal. Such attack is illustrated in Figure 1.

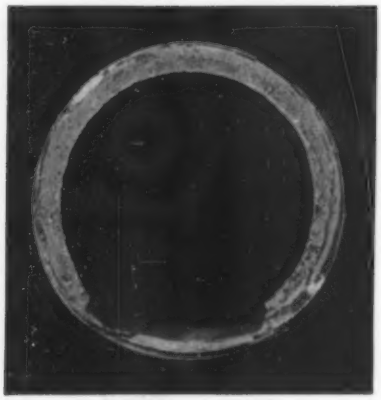


Figure 1—Grooving attack by CO_2 is shown in this end view of the condensate pipe.

Corrosion by dissolved oxygen will be evident by a series of pits, usually accompanied by deposits of the reddish colored iron oxides. Such attack may be observed in Figure 2. It is not uncommon to see the results of attack which is due to both oxygen and carbon dioxide. The appearance of such sections will have the combined characteristics of oxygen pitting and carbon dioxide corrosion grooving.

Figure 2—Oxygen pitting attack, distinctly different from CO_2.

Oxygen Attack

Oxygen in steam and condensate may originate directly from the boiler feedwater or may enter at various points in the condensate system. Boiler water makeup will contain appreciable quantities of dissolved oxygen, especially if taken from a surface supply. Since the solubility of dissolved oxygen decreases with increasing temperature, when the feedwater undergoes an increase in temperature in the boiler itself, the dissolved oxygen will be liberated and passed over with the steam. This fact makes the use of an open or deaerating heater of utmost importance in good engineering design of a boiler plant. With such an installation, the major portion of the oxygen in the water will be removed before the water enters the boiler.

The use of an open or deaerating heater removes the oxygen by mechanical deaeration of the boiler feedwater. Since mechanical deaeration is not successful in removing 100% of the dissolved oxygen present, the feed of a chemical deaerant is economically justified to assure that the last traces of the dissolved oxygen are removed. Ordinarily, sodium sulfite (Na_2SO_3) is used for this purpose.

Recently, hydrazine (N_2H_4) has been applied to achieve oxygen removal. The use of hydrazine is usually confined to high pressure installations where the concentration of dissolved solids is critical. Unlike sodium sulfite, hydrazine does not increase the solids of the boiler water.

Oxygen attack can take place not only due to inefficient deaeration of the feedwater, but also through the possibility of oxygen leakage into the condensate. Air infiltration can be expected at condensate pumps, or other points in the system where air may come in contact with the condensate. This potential difficulty can be checked by conducting dissolved oxygen tests on the condensate itself. If it is determined that oxygen is present in the condensate, appropriate mechanical steps can be taken to eliminate or minimize oxygen infiltration.

Carbon Dioxide Attack

Carbon dioxide is the most prevalent cause of return line corrosion, and its source is primarily the feedwater. An open or deaerating heater will remove any free carbon dioxide from the feedwater, but such removal will not eliminate the presence of carbon dioxide in the steam. Since bicarbonates and carbonates present in boiler feedwater will undergo decomposition at elevated temperatures to form carbon dioxide, the result of this decomposition is the chief source of carbon dioxide in the steam. The reactions are as follows:

(1) $2NaHCO_3 + \text{heat} \rightarrow Na_2CO_3 + CO_2 + H_2O$
bicarbonate + heat → carbonate + carbon dioxide + water

(2) $Na_2CO_3 + H_2O + \text{heat} \rightarrow 2NaOH + CO_2$
carbonate + water + heat → hydroxide + carbon dioxide

While reaction (1) will proceed to 100% completion, the decomposition indicated in reaction (2) proceeds to only about 80% completion. All other things being equal, the higher the carbon dioxide content of the steam, the greater will be the corrosion potential. The severity of the anticipated attack may be roughly estimated by conducting

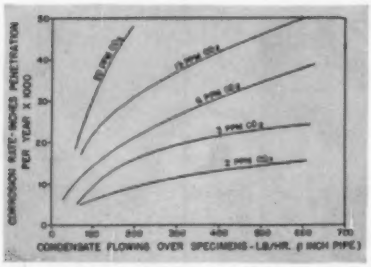


Figure 3—Corrosion rate of CO_2 depends on its concentration and flow rate. Note the drastic rate increase at concentrations above 6 ppm CO_2.

the phenolphthalein and methyl orange alkalinity determinations on the boiler feedwater. In some cases a carbon dioxide concentration as low as 6 ppm may cause a troublesome corrosion problem in the return piping.

However, in addition to the carbon dioxide concentration of the steam, there is one other important consideration in anticipating the severity of corrosion due to carbon dioxide. That consideration is the total pounds of carbon dioxide. Figure 3 clearly illustrates this point. It should be noted that with a carbon dioxide concentration of 6 ppm or above, the rate of corrosion increases rapidly as the rate of flow increases. Another factor which can materially influence the severity of carbon dioxide attack is the possibility of stratification. This leads to a higher rate of attack than expected for the particular flow rate and concentration of carbon dioxide.

Since the carbon dioxide contamination results from an actual breakdown of the carbonate and bicarbonate alkalinity of the feedwater, deaerating practices will be ineffective in reducing the corrosion potential due to this gas. Effective reduction of the corrosion potential may be achieved by external treatment of the feedwater or makeup water to reduce the bicarbonate alkalinity thereof. Such external treating facilities include lime-soda, and lime-gypsum softening, which ordinarily reduce the alkalinity to the 50-60 ppm range. It is advisable, from the standpoint of reducing carbon dioxide corrosion to maintain the softener effluent alkalinity in the carbon-hydrate form, rather than in the form of bicarbonate-carbonate. Other external methods that can be employed to reduce bicarbonate alkalinity to a very low level include acid feed, hydrogen zeolite softening, and dealkalization.

Neutralizing and Filming Amines

When external softening cannot produce a sufficiently low carbon dioxide concentration of the steam, or when the expense for such external treating facilities is not justified, excellent protection from attack can be achieved with the use of neutralizing amines or filming amines.

Neutralization of carbon dioxide can be safely accomplished by certain volatile amines. These amines, when fed to a boiler, volatilize with the steam and combine with the carbon dioxide to neutralize its acidity. Since they react directly with carbon dioxide, the quantity required is proportional to the carbon dioxide content of the steam. Where large amounts of carbon dioxide are present, costs can become excessive.

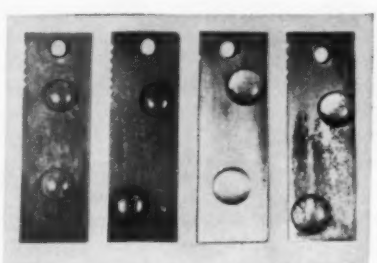


Figure 4—Non-wettability of amine film.

The filming amines function by laying a non-wettable film of monomolecular thickness over the metal surfaces, which is impervious to water. Since the film prevents the water from reaching the metal surface, attack is prevented. The quantity required is independent of the carbon dioxide concentration, and therefore is a more economical treatment particularly where high concentrations of this gas are present. The film forming amines are also effective when oxygen is present in moderate amounts. Figure 4 illustrates the water repellency of the amine film.

Summary

1. Oxygen and carbon dioxide are the chief causes of return line corrosion.
2. Attack by dissolved oxygen is characterized by pits and build-up of deposits of iron oxides.
3. Attack by carbon dioxide is characterized by grooving and actual thinning of the metal pipe walls.
4. Combined attack by oxygen and carbon dioxide will have the characteristics of each.
5. Oxygen attack can be stifled by efficient chemical and mechanical deaeration.
6. Carbon dioxide attack can be inhibited by external reduction of alkalinity and/or use of filming or neutralizing amines.

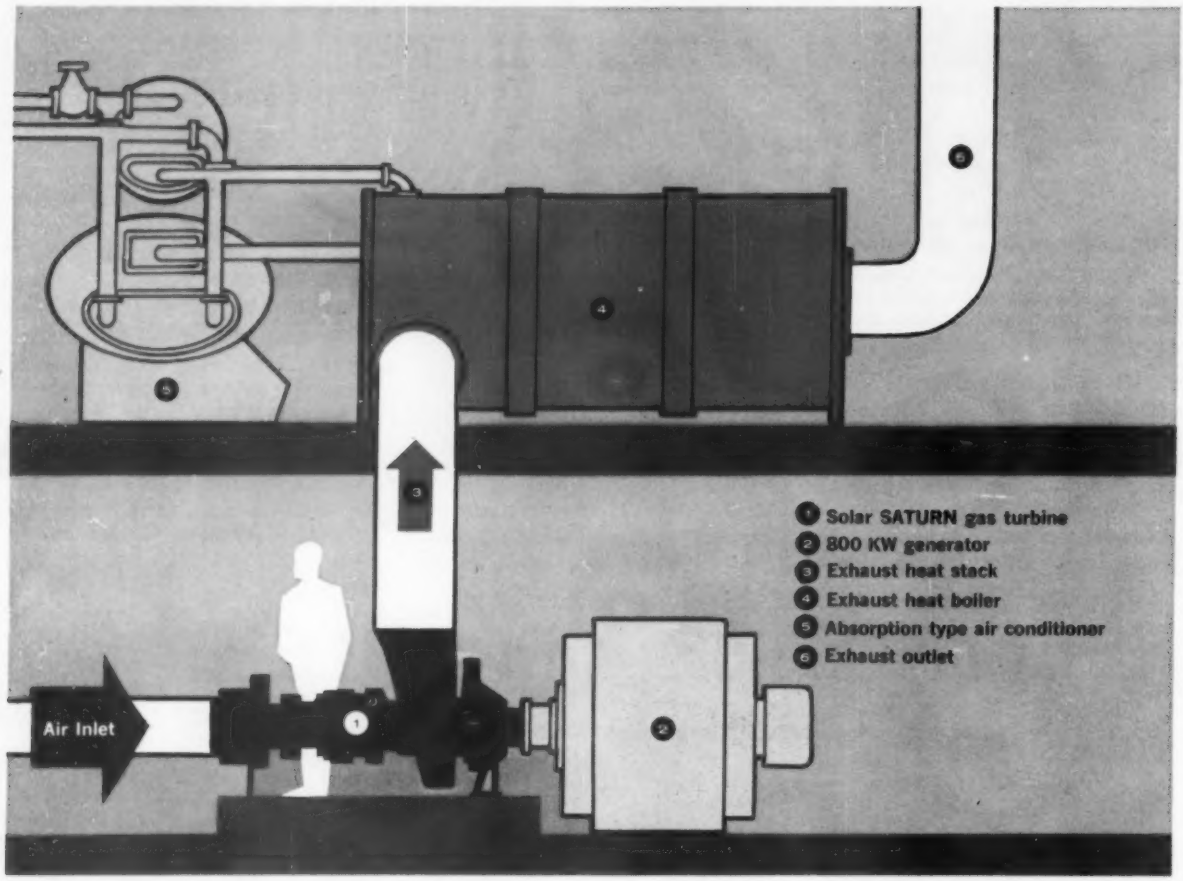
NEED NOT BE A PROBLEM

A number of factors must be considered on an *individual plant basis* to determine the best way to overcome a return line corrosion problem. Continuing research and development by BETZ LABORATORIES on this important subject has led to a better understanding of the effect of different variables, as well as provided increasingly effective control methods. A BETZ Field Engineer will be happy to discuss your return line corrosion problem and suggest result-producing ways to overcome it. Why not take steps to call him in *now* while you're thinking about it?

BETZ LABORATORIES, INC.

Gillingham & Worth Streets • Phila. 24, Pa.

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS



Solar gas turbine exhaust heat multiplies thermal efficiency

This unique system of efficient exhaust energy utilization illustrates one of the many advantages of Solar gas turbines. In addition to the turbine's main shaft power, exhaust gases can be put to work to multiply the thermal efficiency of the installation up to three times that of the prime mover alone.

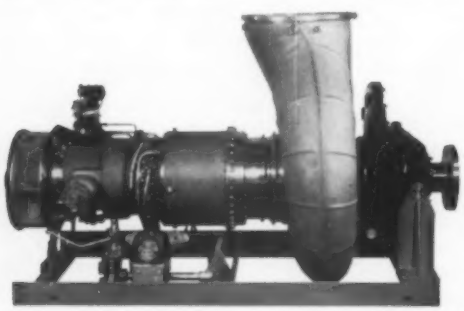
In the typical system illustrated above, Solar *Saturn* gas turbines turn 800 kw generators, providing electricity for lighting and machinery. Turbine exhaust heat is passed through a boiler to provide steam for process or building heat and absorption air conditioning.

This installation with three *Saturn* engines produces 2400 kw of electrical energy and 16,150 lbs of steam per hour. The complete package fits in a 60 ft by 40 ft space. The turbines will run on gasoline, kerosene, diesel fuel and natural or manufactured gas.

Exhaust heat utilization systems are easily adaptable to any job where electric power generation is needed, such as manufacturing and processing plants.

Solar gas turbines with their light weight, compactness, lack of vibration, long life and instant start capabilities are ideally suited for such jobs as electrical power generation, pumping, field and pipeline compression, oil well servicing, vehicle or marine propulsion.

Solar's family of gas turbines, from 50 to 1100 hp, are designed specifically for industrial use. Their design and manufacture are the result of over 15 years of experience. For further information, write to Dept. J-137, Solar Aircraft Company, San Diego 12, California.



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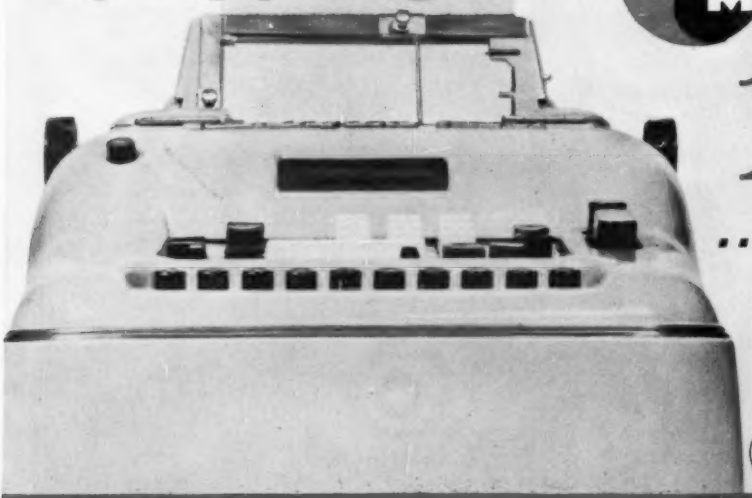

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Copes-Vulcan automatic boiler control at Hammermill Paper Company

Gives good results on steam generator fired with hogged bark and coal

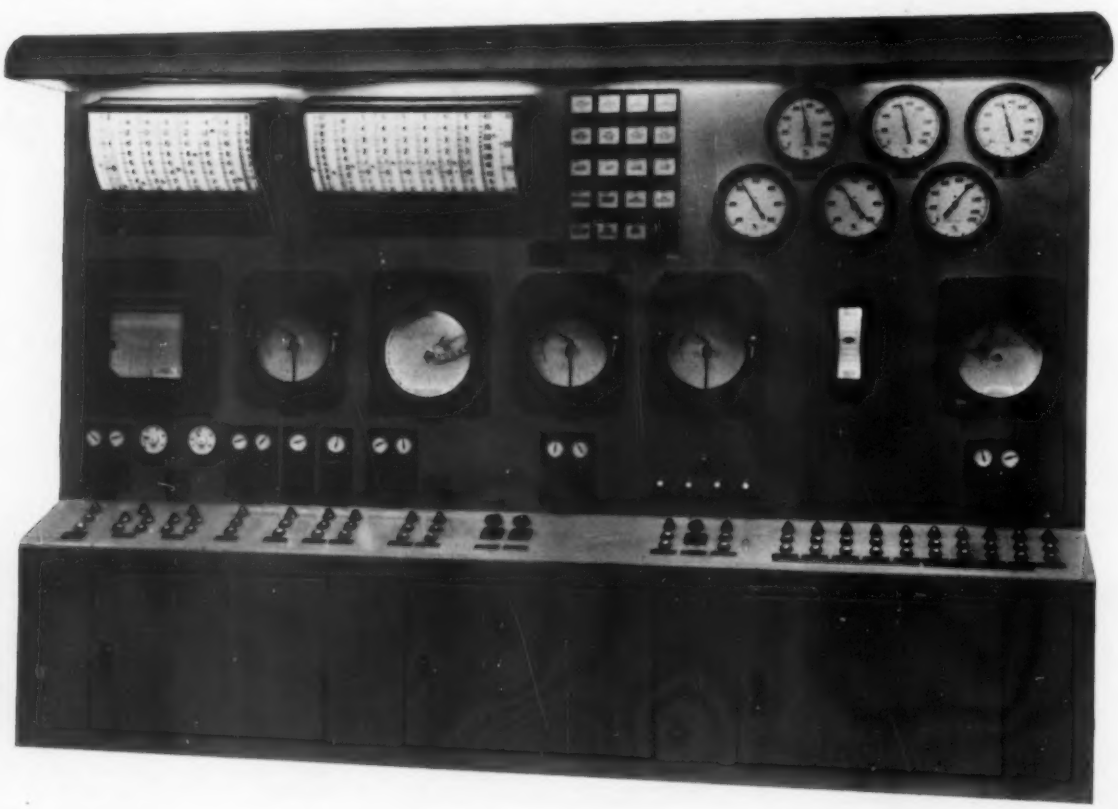
Here was an unusual problem of boiler control. Two solid fuels—hogged bark and bituminous coal—were to be burned in combination. The Riley steam generator, with nominal rating of 206,000 pounds per hour at 675 psig and 760 degrees F., was to deliver power and process steam to the same main header as all other existing boilers. Low steam costs and high boiler availability were a goal of the design and operating engineers.

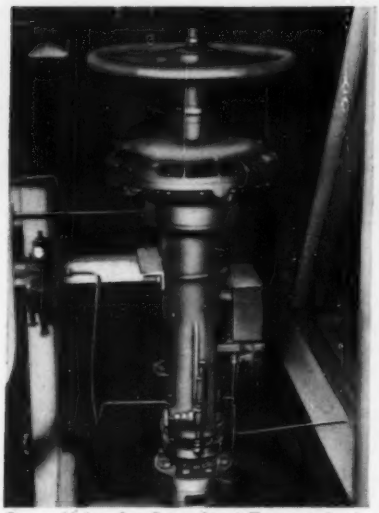
Copes-Vulcan combustion control has given high operating efficiency by close control of excess air. It has minimized fuel-bed disturbances by keeping the flow of air through the bed at the lowest practical rate. It has handled intermittent flows of waste fuel without incident. It has required no manual adjustments for variations in fuel moisture or quality, or in kind of fuel.

Copes-Vulcan three-influence feedwater control has maintained the proper drum level while feeding exactly as needed for steam output. Regardless of load conditions, Copes-Vulcan control has maintained final steam temperature at the desired 760 degrees F.

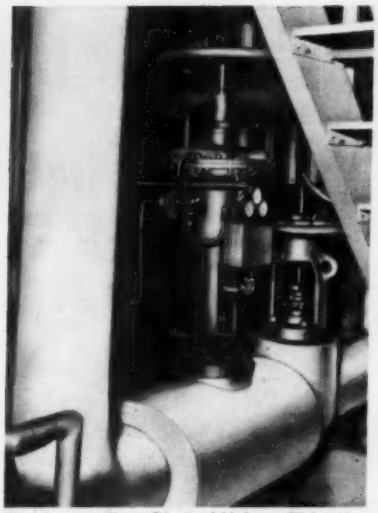
The complete story of this unusual installation is told in new Bulletin 1078. Write for it.

Central Control Panel. All recorders and controls for the bark-and-coal-fired boiler are centralized on this Copes-Vulcan panel.

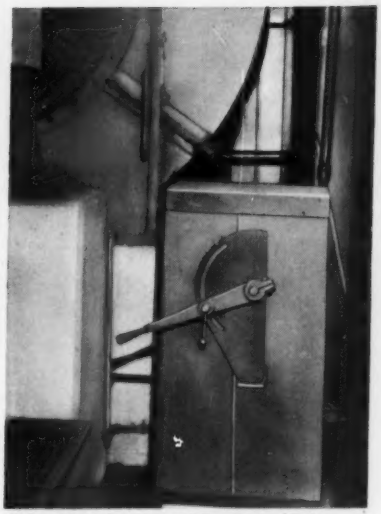




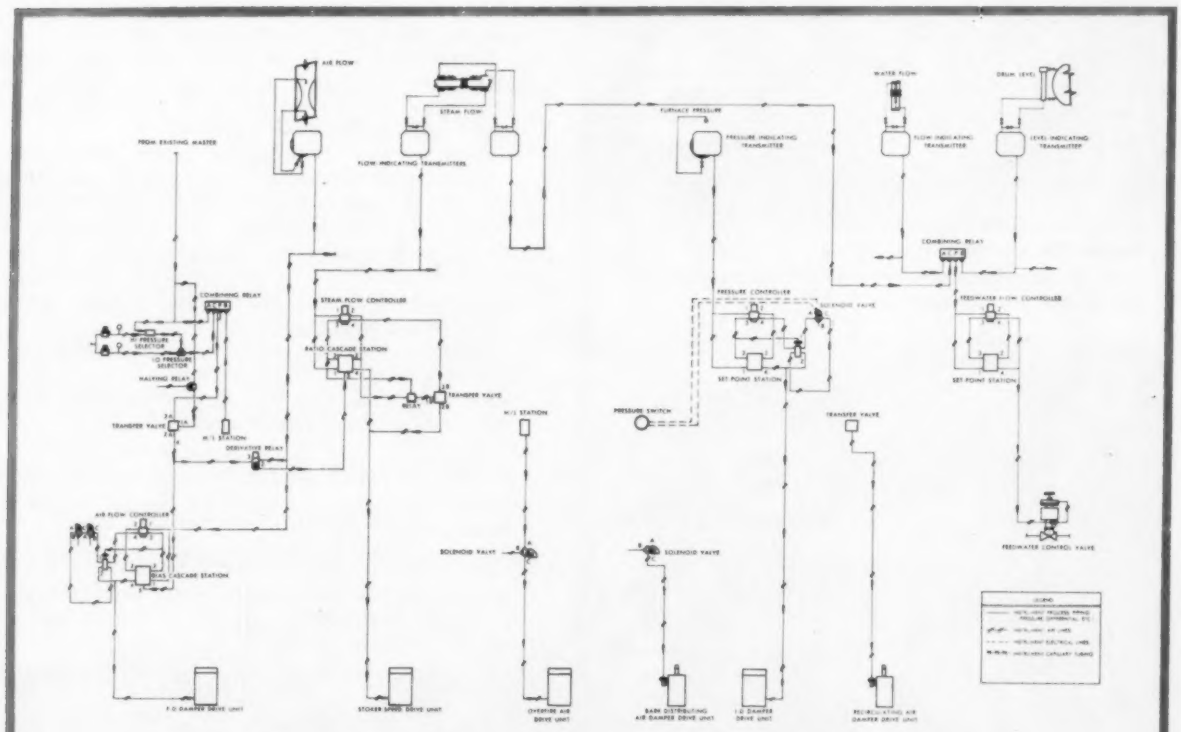
Spray Valve for Superheat Temperature Control. This Copes-Vulcan Type CV-D Spray Valve introduces cooling water into the superheater for dependably accurate steam-temperature control.



Feedwater-Flow Control Valve. This diaphragm-operated Type CV-D valve is part of the Copes-Vulcan three-influence feedwater control system.



Drive Unit for Forced-Draft Fan Damper. This Copes-Vulcan drive unit, one of several in the control system, positions the forced-draft fan damper.



Schematic diagram of the Copes-Vulcan combustion and feed-water control systems on the bark-and-coal-fired boiler at Hammermill Paper Company.

Copes-Vulcan Division

BLAW-KNOX

BLAW-KNOX

Blaw-Knox designs and manufactures for America's growth industries: METALS: Rolling Mills • Steel Processing Lines • Rolls • Castings • Open Hearth Specialties • PROCESSING: Process Design, Engineering and Plant Construction Services • Process Equipment and Pressure Piping • CONSTRUCTION: Concrete and Bituminous Paving Machines • Concrete Batching Plants and Forms • Gratings • AEROSPACE: Fixed and Steerable Antennas • Radio Telescopes • Towers and Special Structures • POWER: Power Plant Specialties and Valves

For more data circle 515 on Post Card

Fills the Job
Fits the Budget
For
Years of Service

MH Merchandiser*

Boyertown "Better Built" Truck Bodies

Model MH Merchandiser. Equipped as a Mobile Workshop for Maintenance Crews Servicing Power Lines and Sub-Station Installations.

Model MH Merchandiser Equipped as a Mobile Shop to do Major Utility Repair Service.

Boyertown offers you the most complete line of standard production truck bodies suitable for every type of business, large or small, commercial, industrial or utility service. The "better built" construction, service proven on the job, permits the use of the standard production body, specially equipped, that will stand up to the toughest jobs.

Boyertown truck bodies, built of all High Strength Alloy Steel providing more strength, having less weight and greater resistance to corrosion means longer lasting, top value equipment.

Body features include full square usable loadspace, easy access to load from cab or rear doors, large cab working area, and unitized body frame construction permitting fast, firm installation of special tools, equipment or fixtures within the loadspace. Sectionalized body construction permits fast replacement of damaged parts by local service departments or garages.

Whether you buy or lease your service truck bodies, contact your Boyertown Sales Engineer or your truck dealer on how Boyertown truck bodies will serve your particular needs best!

***Model MH Merchandiser.** Available with 8' and 18' Loadspace Lengths, Equipped for Special Ambulance-Rescue Work.

Model MH Merchandiser Serving a Water Bureau as a Mobile Maintenance and Repair Shop covering a 60 Sq. Mile User Area.

BOYERTOWN
AUTO BODY WORKS, Inc.
BOYERTOWN, PENNA.

Phone Boyertown FOrest 7-2146 • TWX Boyertown, Pa. 59

For more data circle 516 on Post Card

YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD

HOW YOU CAN SAVE MAINTENANCE...INCREASE OPERATIONAL TIME WITH YARWAY COLOR-PORT GAGES

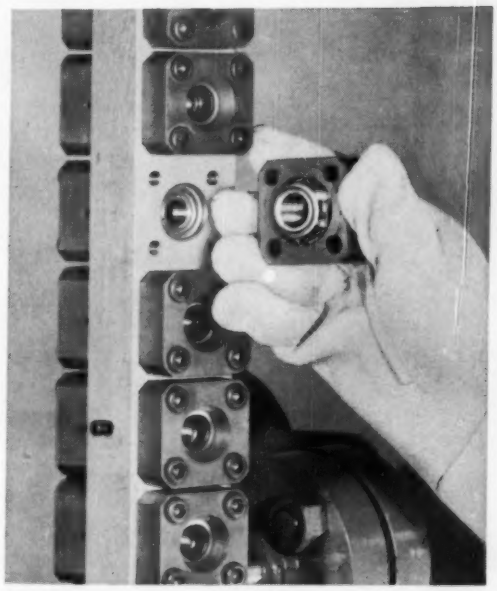
Two big problems confronting the operators of high pressure boilers—excessive maintenance and frequent downtime of water level gages—can be solved with new Yarway Color-Port Gages.

These Color-Port features will help you do the job:

- Patented spring loading of individual port covers, maintains proper pressure on glasses and gaskets at all times.
- Maintenance work can be done *with the gage in place.* NO TORQUE WRENCHES NEEDED!
- Individual "package" port assemblies (glass-mica-gasket) can be replaced in a few minutes.

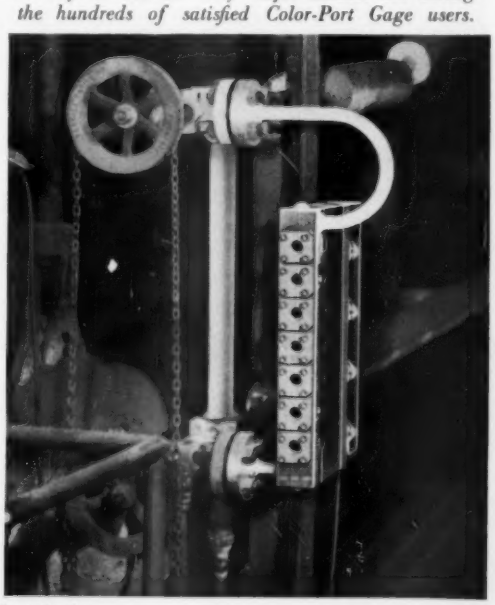
These benefits, PLUS brilliant two-color readings (water space shows green; steam space shows red), PLUS Yarway quality—make COLOR-PORT your best gage buy! 2 Series—1050 psi and 3000 psi.

Write for Yarway Bulletin WG-1815.

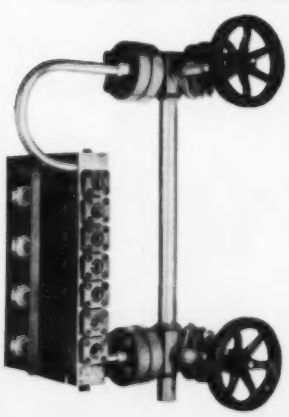


Servicing the Yarway Color-Port Gage is simple! Just remove 4 cap screws (no need for torque wrench), place new "package" assembly in cover, and replace cover assembly. A matter of two or three minutes.

Yarway Color-Port Gage installed on boiler at Alan Wood Steel Co. Leading industrial plants all over the country as well as many major utilities are among the hundreds of satisfied Color-Port Gage users.

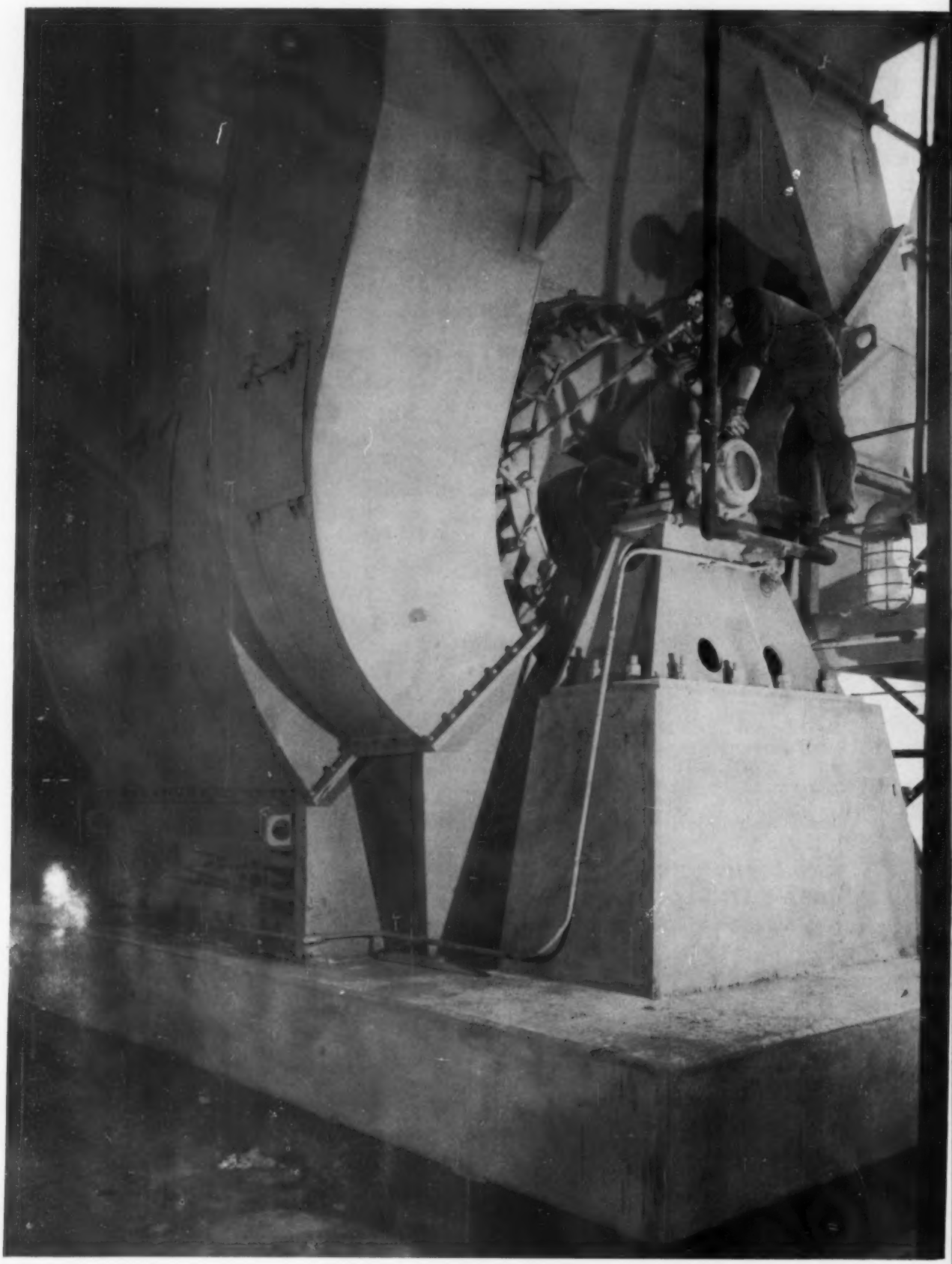


NEW COMPACT DESIGN WITH "WELBLOC" VALVES SAVES INSTALLATION SPACE



New "Welbloc" valves on Yarway Color-Port Gages reduce installation space requirements up to 40%. All working parts of valves are easily accessible. Improved direct flow from boiler drum to gage, reduces temperature differential.

For more data circle 517 on Post Card



RD Fan used for induced draft on basic oxygen furnace of large steel producer. There are four identical units, each producing 325,000 cfm against a static pressure of 15" wg at 550° F.

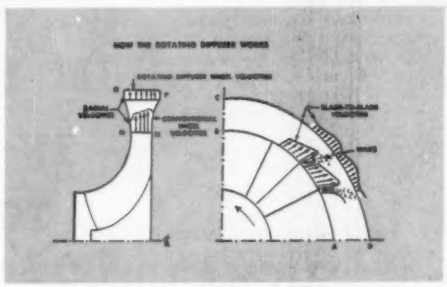
JOY RD FANS CAN PROVIDE PRESSURES UP TO 4.5 PSI AND CAPACITIES UP TO 600,000 CFM

Joy RD Centrifugal Fans, based on a new concept in fan design, can provide any volume of air or gas at pressures up to 4.5 psi in a single stage. This means important savings in initial cost. An equally important saving is their high efficiency over a wide range of volume, which is especially important where load fluctuates. Surging, even on parallel operation, is no problem because the RD Fan is inherently resistant to pressure surge over its entire duty range.

These advantages of the RD Fan are the results of its unique rotating diffuser. Instead of stationary diffusers, the RD diffuser is an integral part of the wheel—added at the blade tips. The rotating diffuser reduces the gas velocity before leaving the wheel and up to 98% of the conversion of velocity to pressure is accomplished with the wheel of the RD Fan.

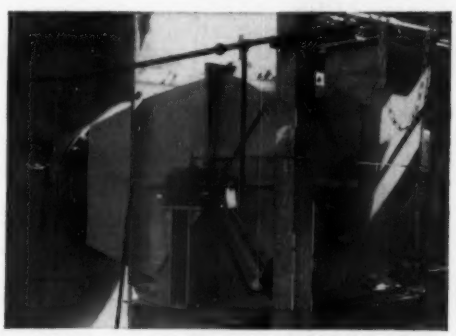
Radial blades in the RD Fan tend to be self cleaning, even when handling dust laden and dirty gases. The rotating diffuser results in low noise levels because of the lower and more regular velocities leaving the wheel and because the blade tips are remote from the cut-off.

The Joy RD Fan is finding steady acceptance in induced draft and forced draft applications in the steel and power industries, in handling chemical process gases, and in heavy duty industrial applications. For extremely dirty or corrosive applications the entire unit may be fabricated of stainless steel. Parts are simple because there are no large castings or close running tolerances. For complete information and duty areas of the RD Fan, write for bulletin 3449-56C.



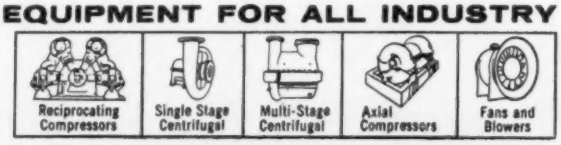
HOW THE ROTATING DIFFUSER WORKS

Studies have shown that radial velocities leaving conventional wheels are unequally distributed, as shown in MN. Also there is fluctuation in the blade-to-blade velocities based on $\frac{nN}{60}$ where n is the number of blades and N is the speed in rpm. The Rotating Diffuser reduces the gas velocity before leaving the wheel, which allows more uniform flow as shown at OP and CD. Without the rotating diffuser, velocities are much higher and erratic as shown at AB and MN, causing turbulence, friction losses.



Joy RD Fan at eastern CO_2 plant. Unit has capacity of 27,800 cfm, at 3 psi. Drive is a 450 hp steam turbine.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

For more data circle 518 on Post Card

THE LARGEST VACUUM FLASH EVAPORATORS IN THE WORLD, TO BE BUILT BY RICHARDSONS, WESTGARTH & CO. LIMITED

The Government of Curaçao has awarded to Richardsons, Westgarth & Co. Limited a contract for two vacuum flash evaporators, each capable of producing from sea water 1,400,000 Imperial gallons of drinking water a day. These will be the largest evaporators ever built.

Richardsons Westgarth, pioneers of the vacuum flash evaporator in Great Britain, now have in operation or on order:

- Vacuum flash evaporators with the largest individual output in the world.
- Vacuum flash evaporators producing the largest total combined output of fresh water in the world.
- More land based vacuum flash evaporators than any other manufacturer.

With plant in operation in Great Britain, South America and many parts of the Middle East, Richardsons Westgarth experience in this highly specialised field is at the disposal of all who require supplies of fresh water for domestic or industrial use.

Consultants for this contract are Stichting Nederlands Adviesbureau Voor Ingenieurswerken in Het Buitenland, The Hague, in association with Tebodin, Advies-en-Constructionbureau NV., The Hague.

RICHARDSONS, WESTGARTH & CO. LIMITED

The controlling Company of the RICHARDSONS WESTGARTH GROUP,
Wallsend, Northumberland, England.
In the U.S.A. and Canada: Richardsons Westgarth Inc. 1926 Eye Street, N.W., Washington 6, D.C, U.S.A., Telephone: Federal 82868

RW93

For more data circle 519 on Post Card

Current Catalogs

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Post Cards provided on pages 97 and 98.

Fans and Blowers

101 Industrial Fans — Bulletin A-1203, 44 pp, describes American-Standard line of HS fans, Series 81, Class I and II. Covers construction features, available drive arrangements, configurations and types of drive. Components are discussed and illustrated. Capacity tables are provided for all 12 sizes, of both single-inlet single-width and double-inlet double-width designs. Outline-type drawings are keyed to tabulated dimensional data.

102 Blowers and Exhausters—Cast iron and fabricated steel blowers and exhausters for standard and special applications are illustrated and described in 16-pp bulletin by Lamson Corp. Technical section includes formulae, friction loss charts and variables that affect pressure and horsepower.

Pumps, Compressors

103 Centrifugal Pumps — Installation, servicing and maintenance of centrifugal pumps is covered in 18-pp Bulletin G-2971 by Worthington Corp. Information includes storage, foundation construction, alignment, piping, priming and starting, lubrication, trouble-shooting, inspection.

104 End-Suction Pumps — Close-coupled end-suction centrifugal pumps are featured in 8-pp Bulletin 108 by Aurora Pump Div., The New York Air Brake Co. Selection and dimensions charts included, also limitations chart.

105 High Vacuum Vapor Pumps — Comprehensive data on performance characteristics and selection of high vacuum vapor pumps is presented in 56-pp illustrated Bulletin 6-1 of Consolidated Vacuum Corp. Applications in high vacuum technology are detailed, procedures for measuring performance of high-vacuum pumps discussed, and speed-pressure curves included.

106 Rugged Sewage Pumps — Vertical, enclosed-shaft, non-clog VCS pumps are described in Chicago Pump's 16-pp Bulletin 124-G. Gives simple method for determining capacities, pump and motor selection tables, layout dimensions and engineering data, optional equipment and installations.

107 Compressors for All Jobs—Sixteen-pp Catalog 20 by Lincoln Engineering Co. gives data on 200 models of gasoline- and electric-driven compressors for industrial and other applications. Features automatic start and stop and constant running units with horizontal or vertical tanks.

Dust and Fume Control

108 Electrostatic Precipitators—Air pollution problems and their solution with electrostatic precipitators are discussed in 12-pp Bulletin 2128 by American-Standard Industrial Div. Principles of operation, specifications and electronic controls are covered.

109 Silicon Rectifier Conversion Unit—Efficiency advantages of a silicon-rectifier conversion unit for electrostatic precipitators are detailed in this bulletin by Buell Engineering Co., Inc.

110 Air Pollution Control—In 12-pp Bulletin 500, Research-Contrell, Inc. illustrates precipitators and other equipment for air pollution control as well as design and manufacturing facilities available. Also shown are some installations in various key industries.

111 Handling Corrosive Fumes — How to handle corrosive fumes with fans, air washers, and exhaust systems made of PVC is detailed in 36-pp Catalog F by Industrial Plastic Fabricators, Inc. Includes dimensional diagrams, performance tables and PVC chemical resistance table.

Mechanical Power Transmission

112 Variable-Speed Drives — Motion-control variable-speed sheaves designed to eliminate freezing and sticking from fretting corrosion are featured by T. B. Wood's Sons Co. in 16-pp Bulletin 25103. Includes horsepower ratings and selection tables.

113 Magnetic Drives—Bulletin 3650, 6-pp, describes magnetic adjustable speed drives available from Louis Allis Co. in ratings from 50 through 2500 hp. Gives details on basic components of this drive, theory of operation, controls and design features.

114 Chain Drives — Easy-to-follow chain drive selection procedures are given in 12-pp Bulletin 611, by Rex Chain Belt Co. Includes seven selection tables arranged for quick determination of sizes, center distances, chain lengths and sprocket ranges.

115 Roller Chain Guide—Presented in file folder format by Atlas Chain & Mfg. Co. are design ideas on efficient use of roller chain. Provides drawings showing use as slat conveyor, reciprocating drive, feed roll drive, chain roller bearing, external gears, internal gears, flexible shaft coupling, rack and pinion table feed, lever actuator, others.

116 Controlled Speed Systems — Systems of automatic speed control for specific industrial applications are described in 8-pp Form F-1952 by U.S. Electrical Motors Inc. Illustrates liquid level control, pressure control, center-wind drive, speed sensitive control, load control, position or link synchronization control, temperature control and others.

117 Roller Chain Couplings—Bulletin 10 features flexible couplings and new coupling cover of Acme Chain Corp. Gives advantages of the couplings, standard sizes, prices. Includes data on couplings with fixed bores and plain bores for reboring.

118 Flexible Cushion Couplings — Selection data, horsepower ratings, dimensions and prices on standard, high speed and flywheel type flexible cushion couplings designed to absorb vibration and compensate for all combinations of shaft misalignment and end float are presented by Dodge Mfg. Corp. in 24-pp Bulletin 901B. Features new larger coupling, also intermediate size.

119 Flexible Couplings—Design and performance advantages of Lovell Mfg. Co.'s flexible couplings are detailed in this 12-pp bulletin. Selection procedure is outlined and data included.

120 Shear Pin Sprockets — Catalog CD-104-A describes Browning Mfg. Co.'s sprockets with shear pin hubs and split taper bushings designed to prevent damage to machinery due to overloading or jamming by shearing the necked pin at a predetermined load.

121 Pneumatic Friction Clutch—In Bulletin 52300, The Federal Machine and Welder Co., tells production, safety and maintenance advantages of Type M-Unit, a pneumatic clutch and brake for crankshaft mounting. Provides easy-to-follow maintenance chart.

122 V-S Belt Data Charted—Wall chart, by Manheim Mfg. & Belting Co., illustrates measuring, coupling and installation of Manheim variable speed belts which can be installed without disassembling enclosed drives.

Valves, Traps, Fittings

124 Rubber Seat Butterfly Valves—Details on adjustable seat butterfly valves are presented by The Henry Pratt Co. in Bulletin 6. Covers models from 3 to 144 in. for pressures from vacuum to 150 psi.

125 Split-Body Control Valve—Bulletin LB4, Conoflow Corp., covers construction and operation of the split-body LB valve and its maintenance-saving features. Tells how it gives spare parts savings, tight shutoff and versatility. Specifications, ordering information and sizing formulae included.

Current Catalogs

126 Ball Valves — Sixteen-pp catalog details specifications and characteristics of Flo-Ball valve line of Hydromatics, Inc. Includes materials of construction charts, pressure/temperature curves, dimension tables, drawings.

127 Surge Arrestor Valve—A cushioned valve designed to automatically open main valve for abnormal or subnormal pressure surges or electrical power failure is described in Bulletin W-16, 16-pp, by Golden-Anderson Valve Specialty Co. Technical details and drawings included.

128 Relief-Unloading Valve—Bulletin S-5, Golden-Anderson Valve Specialty Co., describes automatic relief-unloading valve for steam, air, gas and fluid control service, providing selection data and engineering specifications.

129 Steam Traps—Bulletin 115 by Stickle Steam Specialties Co. covers steam traps for medium and high pressures. Includes data on pressures, sizes, dimensions and prices.

130 Industrial Strainers — Illustrated and described by O. C. Keckley Co. in 24-pp Catalog 61 are Y type and basket patterns, with semi-steel, cast steel, bronze and stainless steel bodies and wide selection of perforated sheet metal and woven metal wire mesh screens. Includes free area to pipe ratios and pressure drop charts.

131 Ductile Iron Fittings—Catalog 3PF, 12-pp, illustrates pipe fittings, bushings and plugs of The Kuhns Bros. Co., showing available stock sizes, prices, pressure ratings and standard specifications met. Includes data on strength, ductility, impact and corrosion resistance, low temperature transition and typical applications.

132 Self-Sealing Couplings—Applications of self-sealing couplings in fluid piping systems are discussed in illustrated 20-pp Bulletin 629 by Aeroquip Corp. Advantages in testing machines or hydraulic systems, connecting tools and other attachments, replacement of two-way shut-off valves, etc. detailed.

133 Flexible Coupling Adapters — Twelve-pp Catalog 1255, of Smith-Blair, Inc., shows how flexible flanged coupling adapters can be incorporated into design of water, sewage, or gas systems or used for "cutting-in" flanged fitting installation in existing pipelines.

Instruments, Controls

134 Standardized Panel Instruments —Specifications on a standardized line of panel instruments are given in Bulletin 01-113, 6-pp. Units are offered in 4½, 5½ and 7½ in. sizes by Daystrom, Inc. The line includes a-c and d-c ammeters, milliammeters, microammeters and voltmeters.

135 Scientific and Test Instruments —Featured in 48-pp revised Catalog G-10b, by Minneapolis-Honeywell Regulator Co., are instruments and systems used in scientific measurement, recording and testing, including amplifiers, components, data handling systems, lab and calibration instruments, magnetic tape instrumentation, nuclear instrumentation, oscillographs, others. Revision includes price range or approximate prices.

136 Solids Flow Meter — Specification Sheet M22-6, by Bailey Meter Co., describes features and application of a solids flow meter for measuring granulated coal, ore and crushed rock in vertical ducts, spouts or pipes. Gives operating and physical characteristics, plus installation requirements.

137 Improved Level Controls — Liquid-powder-solid level controls offering sensitivity up to 250 ft from sensing probe are discussed in technical bulletin released by Fielden Electronics, Inc. Specifications included.

138 Temperature Resistance Sensors —Twelve-pp Form TR of Brush Instruments, Div., Clevite Corp., tells how a universal carrier amplifier and platinum resistance sensor are combined for recording temperatures from -320 to 2000 F. Covers set-up, temperature compensation, bridge circuits.

139 Compact Gages — Small-size gages designed to match performance of larger units, yet requiring less panel space are described in 12-pp Bulletin 321.11 by Republic Flow Meters Co. Lists applications for indicating draft, pressure, differential gas pressure and temperature and pneumatic impulses from transmitters.

140 Valve Positioner — Described in Bulletin 1077 by Copes-Vulcan Div., Blaw-Knox Co., is a positioner for use with diaphragm- or piston-operated control valves, and with pneumatic drive units.

141 Transistorized Analog System — Eight-pp Bulletin GEA-7163 describes General Electric Co.'s frequency telemetering systems and transistorized analog system. Specifications included.

142 Engine Safety Controls — Detailed information on Robertshaw-Fulton's all-pneumatic engine and turbine safety control system are presented in 60-pp Catalog J. Describes complete systems incorporating safety shutdown or warning upon maifunction of measured variables such as temperatures, pressures, levels, speed, vibration.

ELECTRICAL

144 General Purpose Motors — Described in 6-pp Bulletin L-3313A by Kingston-Conley, Inc., are a-c general purpose 56-frame motors for driving such machines as compressors, pumps, high inertia fans and blowers, air conditioners and machine tools.

145 Portable Loading Transformer — Technical Bulletin 446 offered by Knopp Inc., describes a transformer for testing and calibrating of meters, sectionalizers, cables, oil circuit breakers, busses, etc., where currents to 1000 amp are required. Higher ratings may be used intermittently.

146 Magnetic Contactors — Described in 8-pp Bulletin GEA-7326, by General Electric Co., are NEMA Size 3 and 4 contactors and starters with space-saving features. Ordering details and overload relay heater selection tables included.

147 High Voltage Equipment—This 16-pp bulletin by Universal Voltronics Corp. provides information on anti-corona terminations, high voltage d-c supplies, encapsulated power packs and high voltage meters. Technical data on applications included.

148 Breakers, Safety Switches — Comparison guide to costs, sizes, installations and other features of AB-1 circuit breakers and safety switches is offered in this 32-pp pocket-sized booklet by Westinghouse Electric Corp. Highlights advantages of breakers.

149 Low-Voltage Breakers — Features and advantages of low-voltage power circuit breakers are described in 16-pp Bulletin FB-1-6010, Federal Pacific Electric Co. Dimensions, typical test oscillograms, rating tables and application data included.

150 Portable Electric Testers—Circular Z-54, Weston Instruments Div., Daystrom, Inc., shows portable units, including matched a-c, d-c industrial meters, transformer for use as a-c multiplier, highly sensitive d-c portables, multi-purpose industrial instruments. Data on accuracies, ranges, prices included.

151 Miniature Pushbuttons — Twelve-pp Bulletin GEA-7127A contains revised information on General Electric Co.'s industrial miniature oil-tight push buttons. Selection tables list forms and colors available.

> When ordering catalogs, allow time for us to relay your requests to the manufacturers — and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

152 Electrical Tubing, Sleeving — Details on tubing and sleeving for electrical insulation in Class A through Class H temperature applications are presented in 12-pp bulletin by Irvington Div., Minnesota Mining and Mfg. Co. Selector charts included.

Packings, Gaskets, Seals

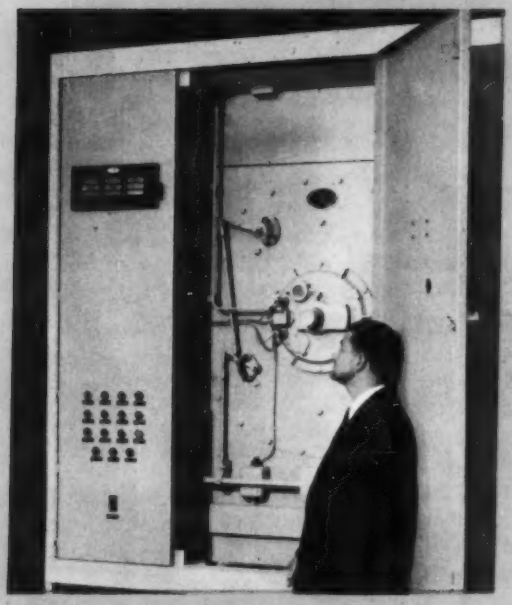
153 Lattice Braid Packings—Characteristics and advantages of braided packings are detailed in 8-pp Form

more Current Catalogs page 97

WHY TWO BUPNERS FOR YOUR LARGE PACKAGE BOILER ?

Unless its furnace has a height to width ratio greater than 1.5 to 1 a **SINGLE BURNER** *fits it better!*

With the Coen Model 60 Fyr-Compak® and its packaged accessories, you get single burner simplicity, dependability and efficiency, plus:



110,000 pph gas only unit for preheated air.

STEAM FLOW RATINGS ABOVE 100,000 PPH
. . . made possible by the controllable flame pattern of the Coen DAZ (Dual Air Zone) Register.

GUARANTEED 10 TO 1 TURNDOWN, GAS OR OIL
. . . automatically (Coen "VO" metering), with unusually high efficiencies at all firing rates . . . electrically or pneumatically.

TWO FLAME SAFEGUARD RELAYS
. . . operating in parallel, provide critical "standby" to assure freedom from non-scheduled shutdowns.

UNINTERRUPTED OPERATION ON MOMENTARY POWER FAILURE
. . . duration of permissible voltage dip increased from ¼ cycle to 30 cycles.

NO REDUCTION IN CAPACITY DURING GUN CHANGE WHEN OIL FIRING
. . . full firing rate transferred to full capacity auxiliary atomizer.

Other factors may also be important. You may want your unit to include the additional limit protection required by F. I. A. You will probably want an annunciator and you may contemplate a fully automatic unit. When fully integrated, completely packaged firing equipment is being considered, these features can be more simply provided in a *single burner* than with two burners.

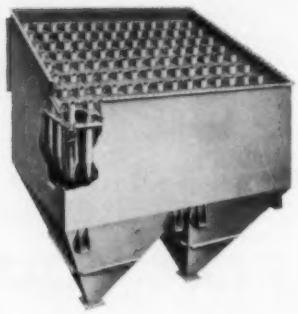
High capacity Model 60 Fyr-Compaks have been giving users outstanding performance for over 2½ years. For full details on how you can get the simplicity and dependability of a single burner for your large package boiler, please write for Bulletin FC-60 or contact any of our sales representatives.

COEN COMPANY

Combustion Engineers and Manufacturers
40 Boardman Place • San Francisco 3
FYR-COMPAK® GAS AND OIL BURNERS; FYR-MONITOR® FLAME SAFEGUARD SYSTEMS
FUEL OIL PUMPING, HEATING & STRAINING SETS; AIR HEATERS; KILN BURNERS
Representatives in principal cities throughout the world

For more data circle 522 on Post Card

TWO COST-SAVING ADVANTAGES OF CYCLO-TRELL MECHANICAL DUST COLLECTOR

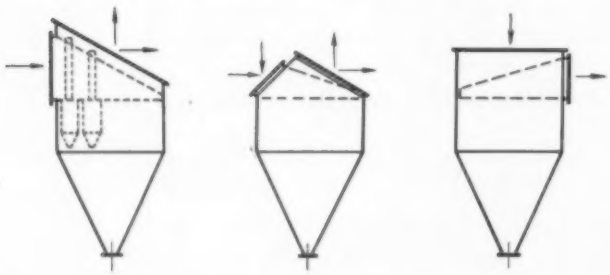


Flexible Design For Low First Cost

Cyclo-trells have been engineered to provide the most economical solution to many gas cleaning problems.

Cyclo-trell's flexible design permits a wide combination of:

- standard 10″, 24″, 24″-lined, IC* and IC-lined collecting tube sizes
- standard inlet and outlet locations
- standard arrangements of the tubes



Most installations are engineered with a combination of these Cyclo-trell designs.

Whenever an installation requires a configuration different from the standard types shown, Research-Cottrell draws on its 49 years of gas cleaning experience in designing a custom-built unit. These custom units may be of the multiple tube or involute design, and are for power, cement, coal drying, chemical, petroleum, mining, quarrying, metals industry, or other applications.

Research-Cottrell engineers have also had wide experience in combining Cyclo-trell collectors with existing precipitators to increase collection efficiencies. This is particularly important when boilers are operating at increased loads and where higher collection efficiencies are required.

Longer Tube Life for Low Maintenance Cost

Actual operating experience in the field has proven that Research-Cottrell tubes last longer.

This experience has led many users of dust collectors to specify Cyclo-trell tubes as replacements.

Two tube types are available. Standard chrome-vanadium tubes having a Brinell Hardness of 290-350, or, at a nominal price addition, for extremely abrasive conditions, tubes having a Brinell Hardness of 500-550 can be supplied. Outlet wear plates are included with the higher Brinell types.

Contact your nearest Research-Cottrell office for complete information on Research's line of mechanical collectors and electrostatic precipitators, or write our main office for Bulletin 300.

*Involute Cyclo-trell

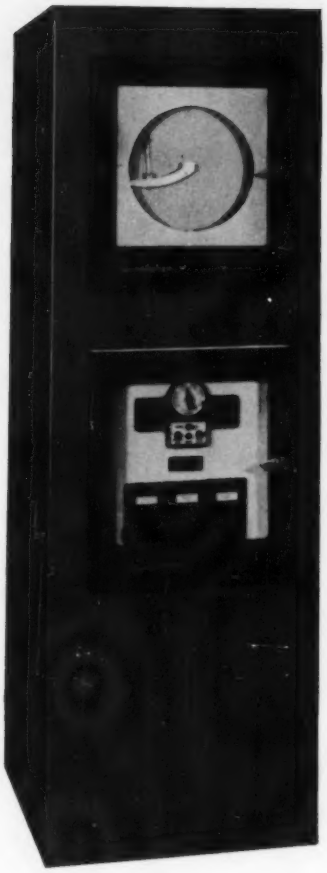
Research-Cottrell

RESEARCH-COTTRELL, INC., Main Office and Plant: Bound Brook, N. J.
Representatives in principal cities of U.S. and Canada.

RC234

MEMBER OF THE INDUSTRIAL GAS CLEANING INSTITUTE

For more data circle 521 on Post Card



AUTOMATIC COLORIMETRIC ANALYSIS

in the parts per billion range

Now you can perform delicate colorimetric analyses for silica and other parts per billion trace contaminants right on the plant floor . . . without supervision. Quantichem® Analyzers continuously, automatically perform every step of a wet laboratory analysis with unprecedented accuracy and dependability. The field-proved Quantichem analyzer is so stable and foolproof that it actually provides *greater accuracy and repeatability than tedious manual techniques.*

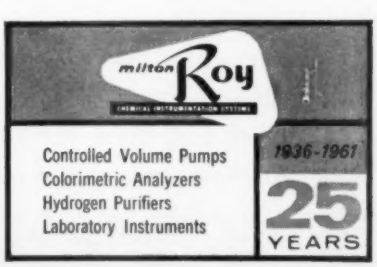
The first step in each Quantichem analysis is standardization, in which *sample* and *zero* cells are flushed with sample while the instrument zeroes itself. Although no Quantichem analyzer has yet exhibited so much as 1% drift in 24 hours, standardization is a valuable safety feature. It ensures results *independent of photoelectric tube characteristics, line voltage variation, sample turbidity, or dirt on the cell windows.* If a dirty cell window or failing light source prevents zeroing, an automatic signal is actuated.

After standardization, the pneumatic programming drum which controls the instrument actuates the unique Minus Delta P® diaphragm metering pumps. Precise amounts of as many as four reagents (within ±0.25%) are delivered to the cells in the desired sequence. The analysis reaction is permitted to go to completion, *eliminating any chance of temperature or timing errors.* The dual beam optical system which illuminates both cells ensures uniform light intensity and *eliminates possible errors due to light source inequality.*

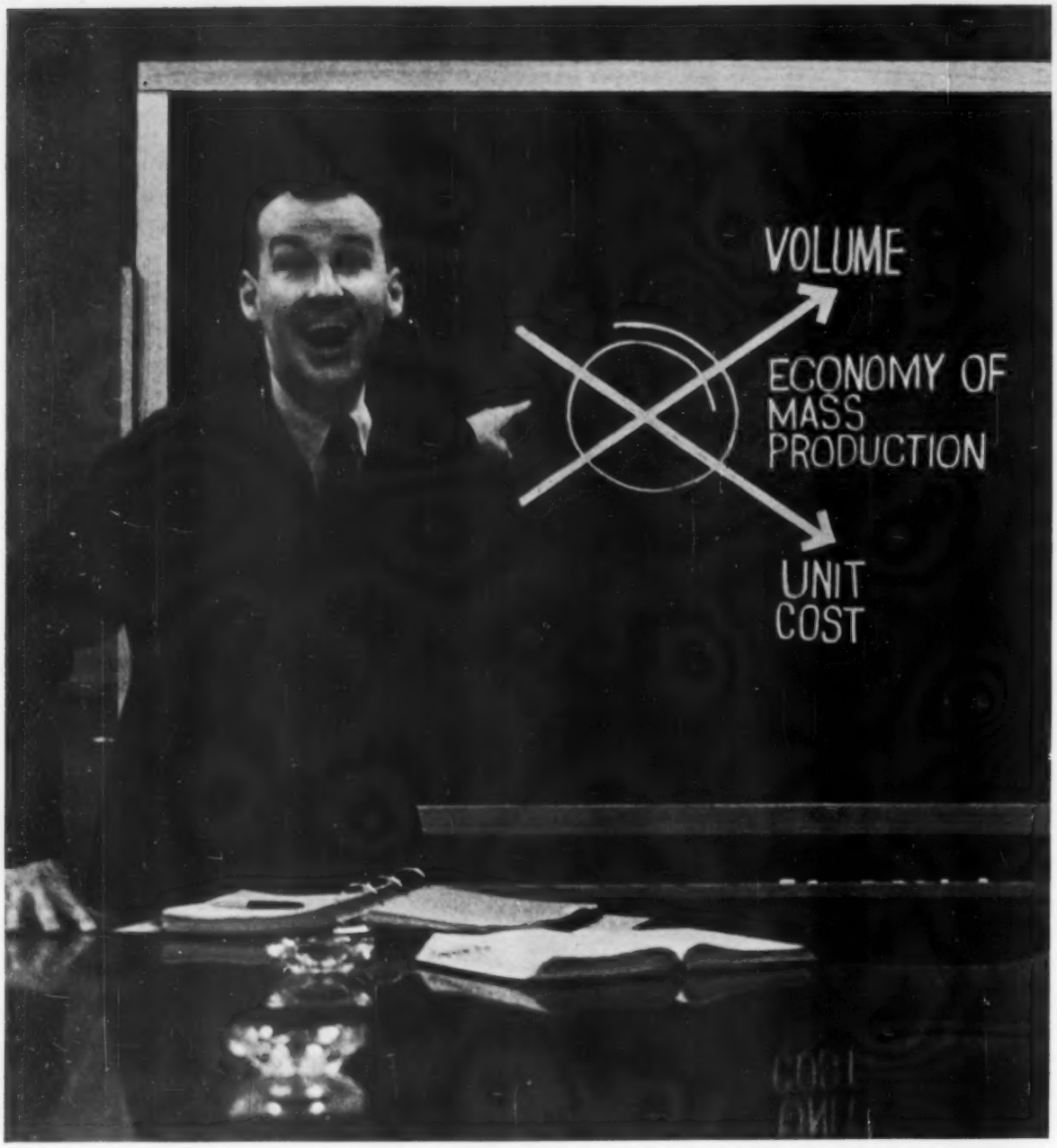
Any difference in light intensity transmitted by the two cells unbalances the measuring bridge circuit, actuating the Quantichem recorder and associated instrumentation. Then a new analysis cycle begins with flushing of the cells and standardization.

Quantichem analyzers are now available for dissolved silica, dissolved oxygen, hydrazine, total hardness, residual chlorine, dissolved iron, and other trace determinations. Most analyses are accurate to within ±3% of full scale, and sensitive to ±1% of full scale. Designed and built to take tough industrial usage, Quantichem analyzers provide long service life with minimum maintenance. All wetted parts are constructed of corrosion-proof materials.

Complete information on them is provided in Bulletin 1156-1, available on request. Write to Milton Roy Company, 1300 E. Mermaid Lane, Philadelphia 18, Pa.



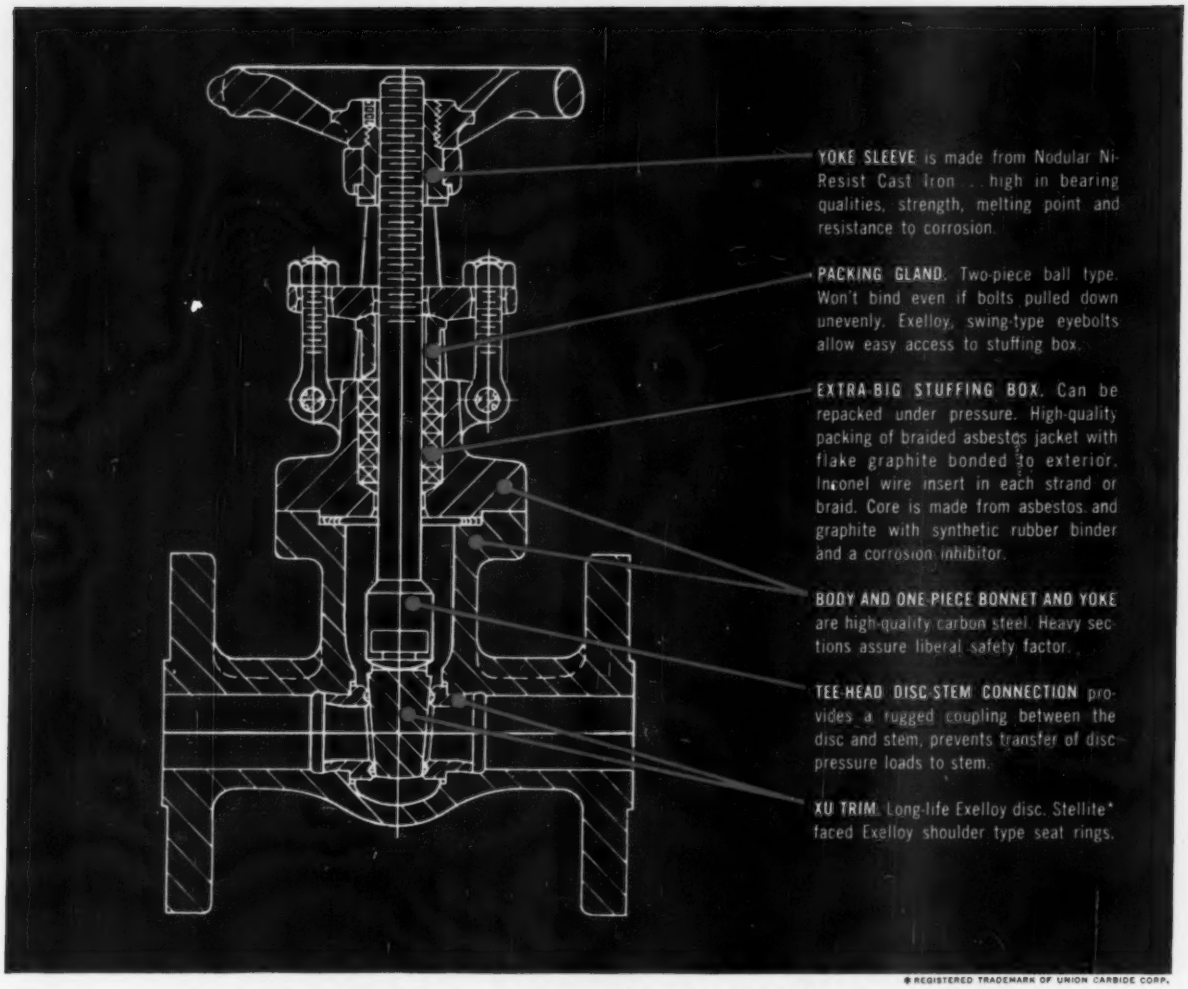
For more data circle 520 on Post Card



Miracle at spot marked X

It happens every day. Advertising builds mass demand. Production goes up—costs come down. More people can buy—more jobs are created. These are the ingredients of economic growth. Each stimulates the next in a cycle of productivity and plenty which constantly creates a better life for you.

Let's Keep Rolling Ahead


YOKE SLEEVE is made from Nodular Ni-Resist Cast Iron . . . high in bearing qualities, strength, melting point and resistance to corrosion.
PACKING GLAND. Two-piece ball type. Won't bind even if bolts pulled down unevenly. Exelloy, swing-type eyebolts allow easy access to stuffing box.
EXTRA-BIG STUFFING BOX. Can be repacked under pressure. High-quality packing of braided asbestos jacket with flake graphite bonded to exterior. Inconel wire insert in each strand or braid. Core is made from asbestos and graphite with synthetic rubber binder and a corrosion inhibitor.
BODY AND ONE-PIECE BONNET AND YOKE are high-quality carbon steel. Heavy sections assure liberal safety factor.
TEE-HEAD DISC-STEM CONNECTION provides a rugged coupling between the disc and stem, prevents transfer of disc pressure loads to stem.
XU TRIM. Long-life Exelloy disc. Stellite* faced Exelloy shoulder type seat rings.

*REGISTERED TRADEMARK OF UNION CARBIDE CORP.

Crane adds flanged 150 & 300-pound steel gate valves to famous 3600 series.

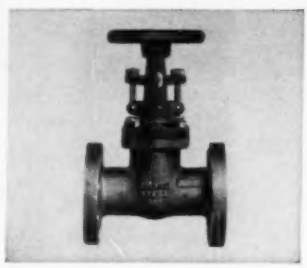
Gives you a complete line of Small Steel Gate Valves suitable for all services at temperatures up to 1000 F. Available in sizes ½" to 2". Gives you design refinements generally associated only with higher priced valves.

The drawing illustrates only a few of the important features of these superior valves. There is built-in quality and reliability in every detail. Outside screw and yoke ruggedly constructed. Stem is heat treated Crane Exelloy. Bonnet joint gasket of spiral wound, Type 316 stainless steel with asbestos filler.

The cast steel 150 & 300-pound valves have "XU" trim and flanged ends (face-to-face conforms to ASA B — 16. 10) . . . figure numbers 3510XU (150 pound) and 3514XU (300 pound). The recently re-designed 3600 series of 600-pound valves is fully described in Crane's No. 60 full line catalog.

All these valves are ideally suited for use with steam, water, air, gas, oil, oil vapor, gasoline, fuel oil and similar services.

More details from your Crane distributor. Or write to Crane Co., Dept. J, Industrial Products Group, 4100 South Kedzie Ave., Chicago 32, Ill. In Canada: Crane Ltd., 1170 Beaver Hall Square, Montreal.

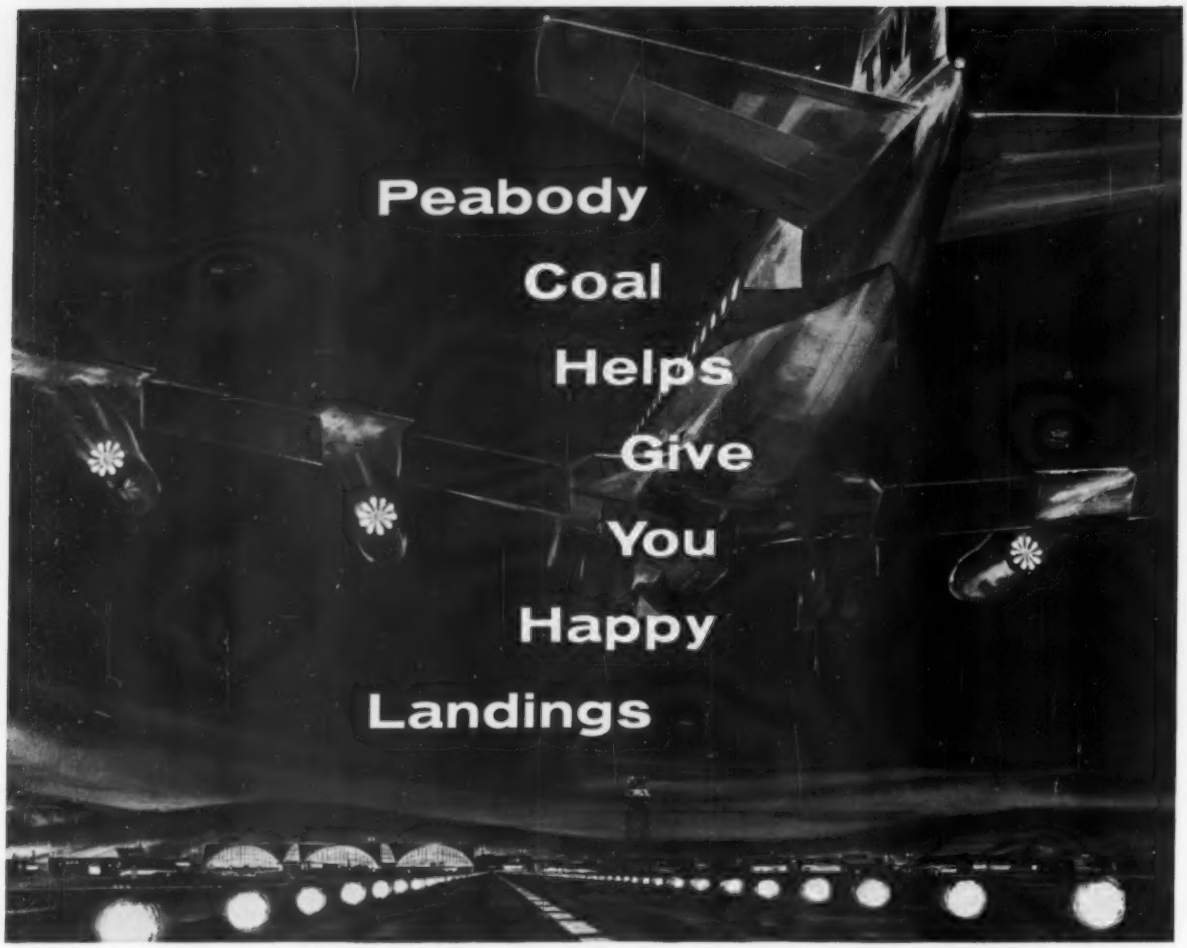


AT THE
HEART
OF HOME AND
INDUSTRY

CRANE

VALVES AND PIPING
ELECTRONIC CONTROLS
PLUMBING
HEATING • AIR CONDITIONING

For more data circle 523 on Post Card



Peabody Coal Helps Generate the Electricity That Lights Runways and Powers Electronic Ground Control Equipment to Make Your Flights Safer

Coal helps a pilot's night-vision a lot more than carrots. Coal generates most of the electricity that lights those friendly runways and supplies power for the ground-to-air control equipment. In fact, coal generates more electricity than all of the other fuels and water power combined.

In our homes, offices and plants, day and night, coal serves us in countless ways, yet coal prices have remained virtually unchanged for many years. This has helped the nation's great Electric Utilities provide you with *more* and *better* services at low cost. Peabody Coal Company, with over two billion tons of proven reserves, supplies many of the leading Electric Utilities that bring you this dependable, economical power . . . at a price you can afford to pay.

If you are seeking a new plant site, Peabody can be of assistance to you. Contact us for information on strategic industrial locations. No obligation, of course! Call today or write Department PE.

power for progress

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Nalco Treatment Technique Protects Non-Wetted Cooling Tower Sections from Microbiological Attack

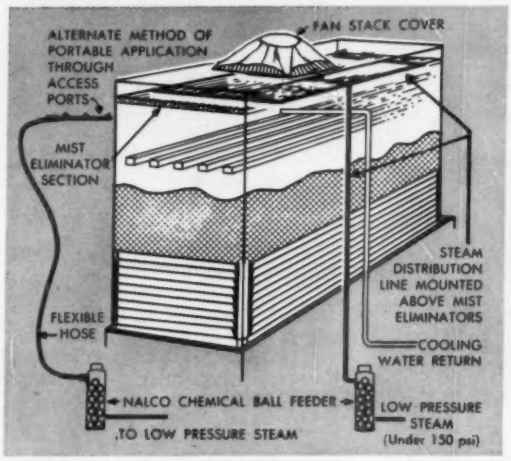
Simple, Low-Cost Method Delivers Effective Chemical to Non-Wetted Tower Areas

Tower sections above the water distribution level have presented a tough protection problem. Chemicals in the water rarely reach fan stacks, top decks, plenum chambers and mist eliminators in sufficient concentration to be completely effective. All of these areas are subject to damaging wood rot caused by microbiological attack. Consequently, a difficult manual spray method has been used to combat this problem. Nalco now recommends using a steam application method to carry powerful microbiocides into the non-wetted areas as a positive method of reaching *all* non-wetted surfaces. The technique is simple, low-cost, and has proved very effective in keeping non-wetted lumber rot-free.

How Steam Treatment Works

Fans are shut down, and fan stacks covered. It is possible to circulate water in the tower during steam treatment, but faster results can be had if circulation is also stopped. Low pressure steam is directed through a container of *Nalco* ball briquette microbiocide chemicals, which are carried with the steam. Perforated steam pipes, inserted into the plenum chamber, carry the steam chemicals into all spaces above the water distribution lines, permitting the chemicals to penetrate wood surfaces and providing protection against wood rot.

These test blocks were placed on a nutrient agar inoculated with a known wood rot organism. Test blocks A and B had been removed from a tower treated with Nalco steam spray. Test block C had not been treated. Notice extreme accumulation of fungal organisms on untreated block C.


ALTERNATE METHOD OF PORTABLE APPLICATION THROUGH ACCESS PORTS
FAN STACK COVER
MIST ELIMINATOR SECTION
STEAM DISTRIBUTION LINE MOUNTED ABOVE MIST ELIMINATORS
FLEXIBLE HOSE
COOLING WATER RETURN
NALCO CHEMICAL BALL FEEDER
LOW PRESSURE STEAM (Under 150 psi)
TO LOW PRESSURE STEAM

Typical installation of the Nalco steam spray system.

Portable or Permanent?

A number of Nalco-treated cooling towers have been equipped with permanently-installed steam pipes for microbiological control. Others are treated with steam lines and feeding equipment which is put in place for treatment, but moved from tower to tower as needed. Either way, this Nalco technique is providing a degree of economical protection that controls the wood rot hazard, removing it from the list of operators' problems.

Follow-Through Assistance

Your Nalco Representative will be glad to give you details on how your cooling tower non-wetted sections can be protected effectively; and tell you whether your towers need this treatment now. If steam treatment is indicated, he will help set up the necessary equipment, supervise application to assure results, and make periodic checks on the continuing effectiveness of the treatment.

Chemical microbiocides used for steaming are compatible with other *Nalco* chemicals used in cooling towers for stabilization, water-borne microbiological control, and scale and corrosion control. Your Nalco Representative is an expert in this area, too . . . Use his knowledge and experience—backed by the world's largest water treatment service organization—to solve *all* your cooling water treatment problems. Call him today, or write direct, for Prints 264, 265 and 266 which define steam spray application.

NALCO CHEMICAL COMPANY
6224 West 66th Place • Chicago 38, Illinois

Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany
In Canada: Alchem Limited, Burlington, Ontario

Nalco® . . . Serving Industry through Practical Applied Science

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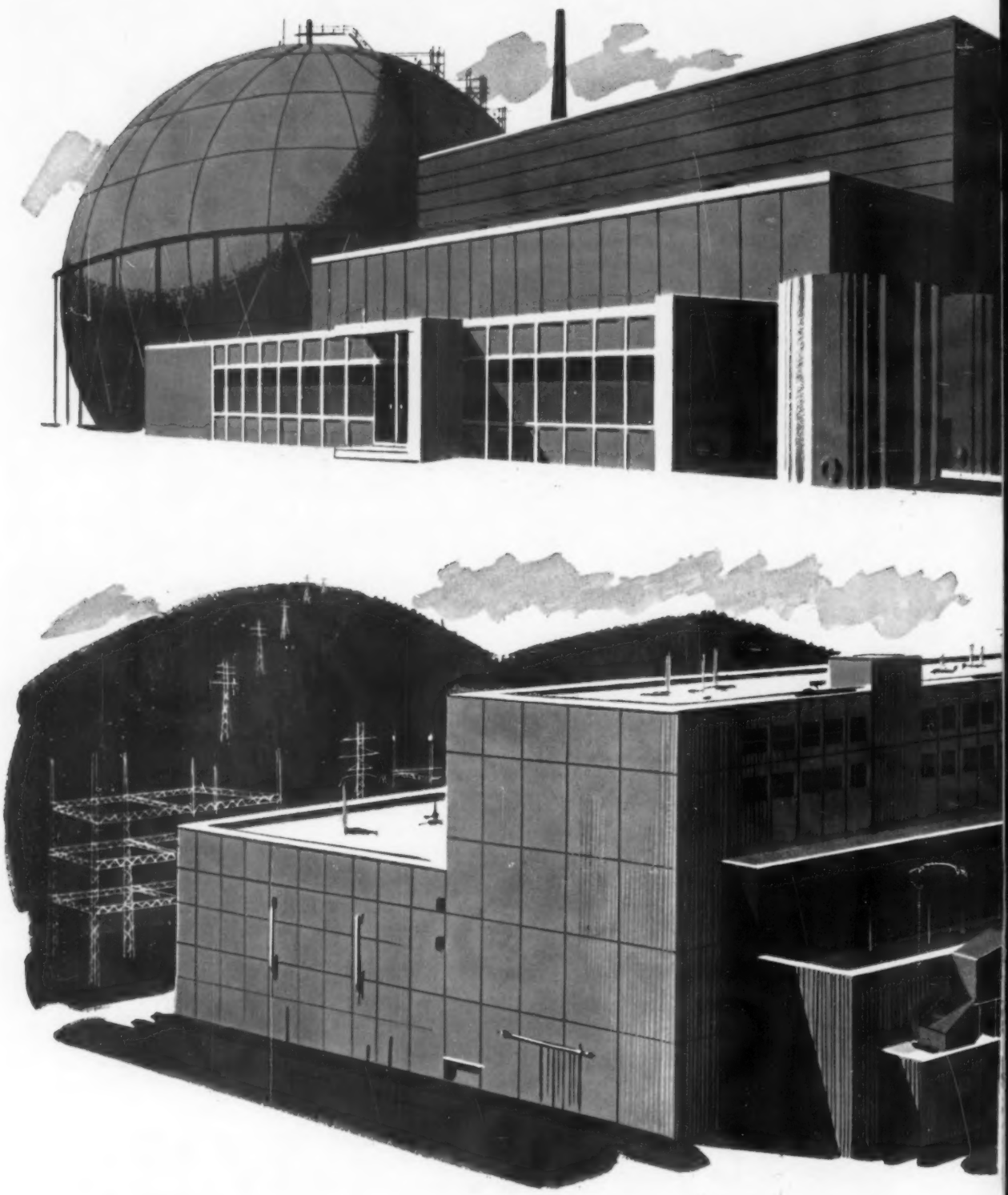

POWER PLANT PRODUCTS HEAT ENGINEERED BY FOSTER WHEELER:
Central Station and Industrial Steam Generators • Steam Condensers and Pumps • Cooling Towers
Pulverized Fuel Systems • Feedwater Heaters • Packaged Steam Generators • Nuclear Components

Whatever the challenge

Atomic power plants were not achieved overnight. In a large measure they were built on fundamental knowledge developed for conventional steam power plants.

Thoroughly grounded in these fundamentals, Foster Wheeler has designed, engineered and built more nuclear steam generators than any other firm in the world.

Today, nuclear-born technology at Foster Wheeler contributes directly to superior equipment of every description . . . equipment that earns a better return on plant investment.

Foster Wheeler designs and builds utility, industrial and marine steam generators; pulverized fuel systems, steam condensers, feedwater heaters, nuclear components, cooling towers, pressure vessels, oil refineries; chemical, petro-chemical and industrial processing plants. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

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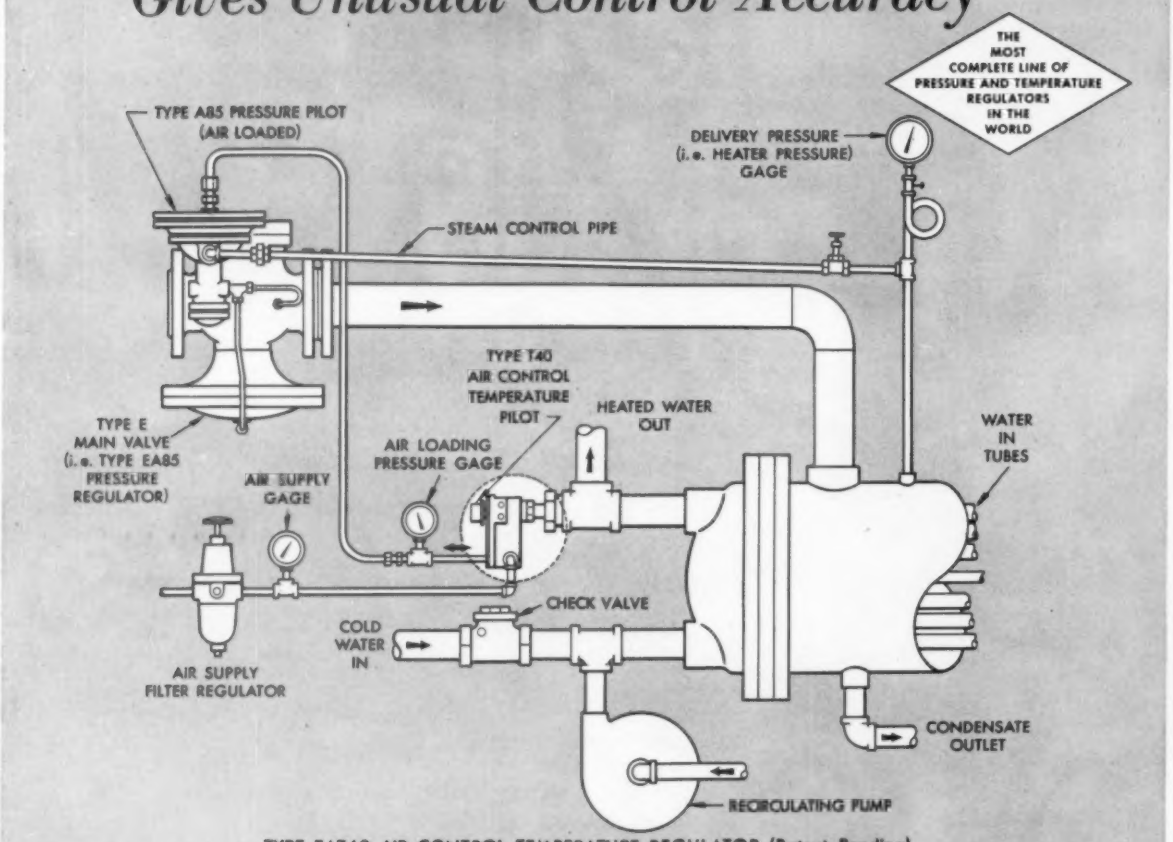
New Spence Temperature Control System Gives Unusual Control Accuracy


THE MOST COMPLETE LINE OF PRESSURE AND TEMPERATURE REGULATORS IN THE WORLD
TYPE A85 PRESSURE PILOT (AIR LOADED)
DELIVERY PRESSURE (i.e. HEATER PRESSURE) GAGE
STEAM CONTROL PIPE
TYPE T40 AIR CONTROL TEMPERATURE PILOT
HEATED WATER OUT
WATER IN TUBES
TYPE E MAIN VALVE (i.e. TYPE EA85 PRESSURE REGULATOR)
AIR LOADING PRESSURE GAGE
AIR SUPPLY GAGE
CHECK VALVE
COLD WATER IN
AIR SUPPLY FILTER REGULATOR
CONDENSATE OUTLET
RECIRCULATING PUMP

TYPE EAT40 AIR-CONTROL TEMPERATURE REGULATOR (Patent Pending)

In a recent installation the new Spence air-control temperature regulating system provided:

- ±5°F control accuracy under wide and instantaneous load swings of 210 to 80 gallons per minute.
- Up to 50% reduction in cost as compared to instrument systems of similar accuracy.

This unique cascade-type control with throttling range adjustment independent of maximum heater pressure was developed to meet today's demand for greater control accuracy.

Additional features of the new Spence Temperature Control System include:

- 200°F wide adjustable temperature range
- Adjustable speed of steam pressure change
- Over and under temperature protection
- Pressure limit control
- Fast response
- Very low air consumption
- Field reversible for heating or cooling

The Spence Type EAT Air Control Temperature System, when properly installed, will tame wide ranging, fast changing loads of instantaneous heaters and modern heat exchangers. The cascade principle plus the use of an extremely fast responding bi-metal temperature sensing element reduce time lags and provide control stability.

Here's how the new Spence system operates:

Quick response is based on a bi-metal temperature sensing element.

Temperature pilot continuously regulates a loading air pressure.

This loading signal, when applied to a pressure regulator to reflect heater temperatures, causes it to adjust the main valve as changes in load require.

Spence has also developed a new pressure control system based on this same cascade principle. This system has a control accuracy of ½ psi or better from positive pressures through the vacuum range to 30" Hg.

For complete information on these new air controlled temperature and pressure control systems, write for your copy of Bulletin 9.

SPENCE ENGINEERING COMPANY, INC.
Walden 1, New York

SE-148

For more data circle 527 on Post Card

Power plant stretches diesel service -cuts maintenance costs- with AMERICAN® D&G Oil No. 53

By C. F. KLENNER Carl Klenner is a specialist at helping customers with their lubrication problems. A graduate of the Michigan College of Mining and Technology, he has been serving commercial customers since 1948. He also attended the Company's Sales Engineering School.

★ ★ ★

At Roseau, Minnesota, the Municipal Power Plant uses Fairbanks Morse Diesel Engines for the generation of the city's electricity. And since 1946, lubricating oils supplied by our Company have played an important part in the excellent maintenance of this plant.

For example, diesel unit number two was overhauled in 1954 after six years' service. At our recommendation, AMERICAN D&G Oil No. 53 was put in the crankcase at that time. After 19,000 hours of oil service, the unit was taken down again. All rings were free, bearings and rings showed minimum wear, and there was negligible carbon on the piston skirts. With AMERICAN D&G Oil, this unit has averaged 4,584 horsepower-hours per gallon of oil.

For additional information about AMERICAN D&G Oil, contact your nearby American Oil Office.

American's C. F. Klenner checks performance reports with power plant superintendent Carl Grand.

Quick facts about
AMERICAN D&G Oil

- Made from highest quality solvent-refined stock.
- Contains additives which impart superior detergent-dispersant and anti-corrosion properties.
- Anti-foaming.
- Oxidation resistant.
- Recommended for
  —use with economy fuels.
  —extreme load service.
  —low temperature service.

AMERICAN OIL COMPANY
910 S. Michigan Ave., Chicago 80, Ill.

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This is AMERICAN OIL COMPANY in action

ONE OF A SERIES OF CHATS ABOUT THE CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

WHY THE BIG STRAIN?

It's tough to keep gases and liquids "clean" as they run through a pipe. They drag impurities along, which can make even plain water a trouble maker, let alone more sophisticated fluids. That's because water, as a liquid or steam, is intimately involved with vital equipment like steam traps, temperature regulators, or tools. Meters, burners, nozzles, and pumps, too.

By this time you must realize we're going to talk strainers, don't you? A good, stout subject, of interest to all who feel production belongs up and costs belong down. Sarco makes strainers for water and condensate, steam, oil, air, gas and other piped fluids . . . dozens of different sizes and types and ratings of strainers to match every application need. Even our line of plain and simple strainers is built for super service. These are pipeline strainers, types AT, BT, and CT, which are designed for 250, 250 and 600 psi non shock, respectively, and 475°, 450° and 750°F. temperature ratings. Standard screens are heavy-gauge, perforated brass or stainless steel. Sarco specializes in screens that can withstand abnormal pressure differentials created by accumulated sediment.

Next, Sarco's flanged strainers, type D. These come in larger sizes, right up to 12", and are available in standard or extra heavy types.

And finally, *Sarco scraper strainers*, manual or motorized. These are the really eye-popping models, and if you can't use one yourself — well — you'll just have to get your kicks elsewhere.

Examples? Take Inland Steel Company at East Chicago, which gets water from Lake Michigan to cool its large air conditioner condensers. The water used to pass through traveling screens, but still contained fine sand. Clogging!

Heat under collars! Frequent cleaning required! Sometimes practically no air conditioning on hot days. (Isn't that always the way?)

The Inland Steel people installed Sarco Rotary Scraper Strainers, Type VRS, which incorporate a hand-operated helical scraper knife within the cylindrical strainer screen. A few turns of the crank at regular intervals, and the sand is scraped off the screen, blown clear, and discharged at pressure through a manual valve to waste. Dismantle the strainer? Shut down the unit? Not *this* strainer!

Now, as long as we've come this far, it's only a hop and a skip to the Firestone Tire and Rubber Co. in Akron, Ohio, who also use water in tremendous quantities. They circulate it through tire presses and a cooling tower, and there's no nonsense about it. It *has* to be clean or damage to equipment could be downright catastrophic. When the plant

modernized and enlarged, Firestone replaced their 4" Sarco hand-operated scraper strainer, type VRS, with a larger Sarco 8" model. And while they were about it, they got the motor-operated type, for continuous cleaning.

When we say that companies like these want the insurance of a Sarco strainer, it sounds like advertisingese, but sometimes there just isn't any other way to put it. Sarco strainers *are* insurance at low cost on the operation of your high cost equipment. So when we ask if you have lumps in your pumps, or worries over your slurries, we're *serious*. We've heard everything in the straining line, so why not write us for literature and answers to those special problems you have.

A T-44 IS THE BEST POLICY

Sorry, but we can't leave the subject of insurance without bringing to your attention one of the best little insurance policies any company requiring cooling control could invest in. It's the *self-powered* Sarco T-44 Automatic Cooling Control. No compressed air or electricity is needed, but its advantages are best described in terms of three different plants of just one Sarco customer — Revere Copper and Brass, Inc.

Revere-Baltimore, Md., has cut water use 40 to 50% with T-44's. But in addition to former water waste, Revere had even more problems: possible wet air from uncontrolled cooling of compressor aftercoolers, plus sweating compressor cylinders; variations in viscosity of hydraulic oil and bearing oil; gas generator water waste; unreliability of manual shut-off of water supply when machines were down.

If your ears perk up in sympathy at mention of any of these problems, the results of Revere's cooling control program should bring you to full attention. One large compressor that had gulped 2400 gallons per hour now takes only 420 gallon sips. In addition all the problems itemized above were solved. T-44's are now used on their air compressors, gas generators, and hydraulic oil systems. At Revere-Riverside, Cal., water savings of 50% were experienced, and at Revere-Rome, N. Y., substantial savings were made too.

But after all, wasting water is only one way of wasting money, so let's go on to another matter of interest: the evils of manual control. When cooling water is controlled by hand the temptation to leave the valve nearly wide open is almost overpowering, in order to play it safe if the load varies. Result: overcooling, of course. And varying the flow runs the risk of undercooling. In either case, lowered process efficiency. Answer: The automatic Sarco T-44, which can't be tempted, is meticulously honest, unsentimental, and plain inhumanly practical when it comes to cooling control. You really ought to write for literature. T-44 is your best policy.

SPARE PARTS INSURANCE

As long as we're near the end, and still on this subject of insurance, may we graciously leave you with this valuable tip? No matter how closely a steam trap approaches perfection, some gremlin may cause it to act up. It's conceivable. So, keep on hand a parts list and spares of key parts for your steam traps and other system components. Parts are small and worth their weight in gold when you need them. A Sarco field engineer will make up a suggested list for you, if you tell us what components make up your system.

Might as well even keep a disc or two on hand for your Sarco Thermo-Dynamic Steam Traps, Type TD-50, even though they're so trouble-free our salesmen keep complaining about the lack of replacement parts business. We'll be glad to tell you about this unique steam trap in case you still don't know how miraculously simple and effective it is.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both — to the point where you'll communicate.

5903

SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

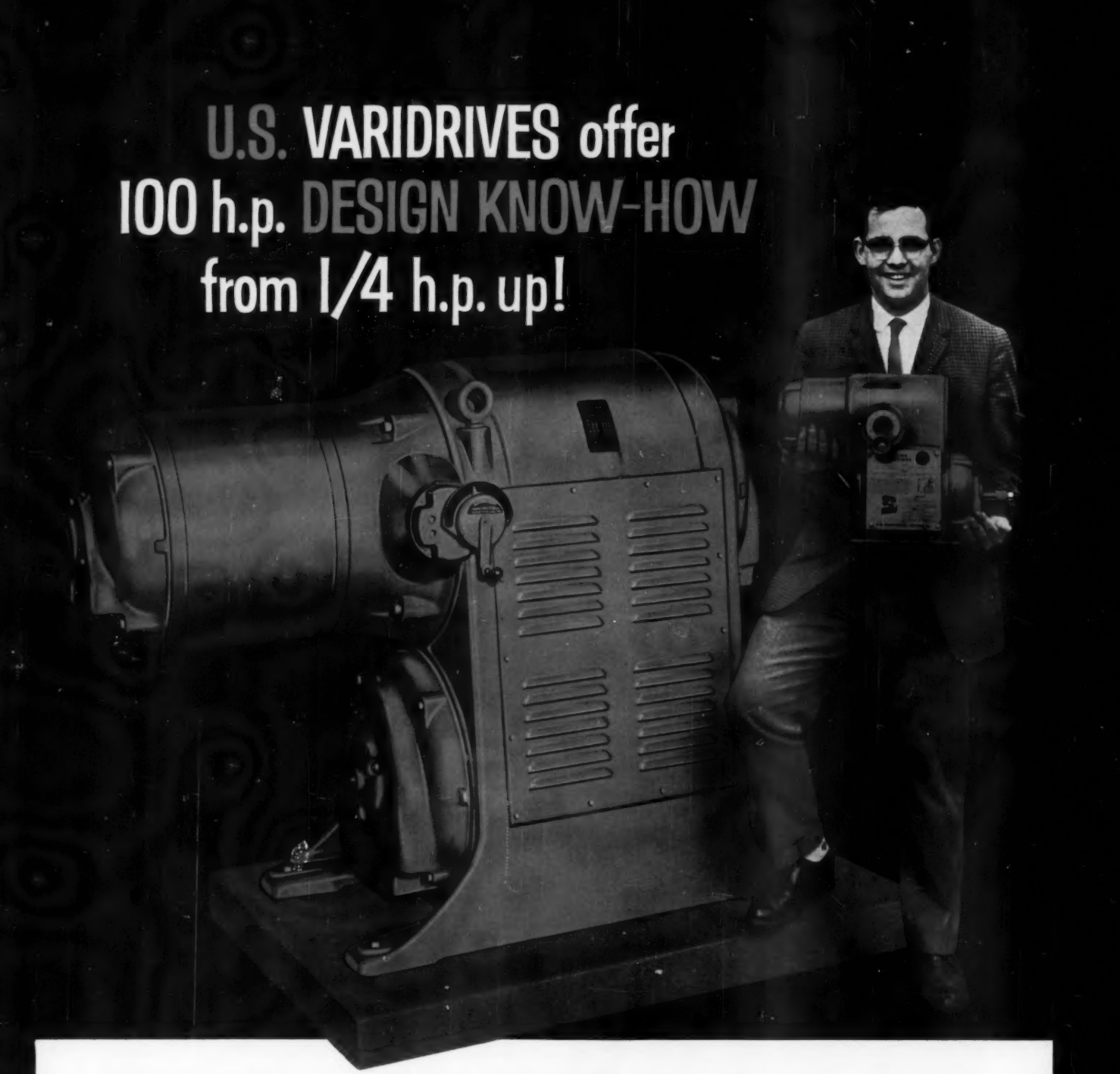
STEAM TRAPS • TEMPERATURE CONTROLLERS
STRAINERS • HEATING SPECIALTIES

Pipeline Strainer
For more data circle 529 on Post Card

T-44 Cooling Control
For more data circle 530 on Post Card

Steam Trap, Type TD-50
For more data circle 531 on Post Card

U.S. VARIDRIVES offer 100 h.p. DESIGN KNOW-HOW from 1/4 h.p. up!



NOW we offer 100 h.p. U.S. VARIDRIVE MOTORS, another link in the long chain of design developments pioneered by U.S. Motors. From the time we offered the first VARIDRIVES 29 years ago, right on up the line to today's 100 h.p. model, U.S. design ability has kept VARIDRIVES years ahead. With U.S. VARIDRIVES you are not limited to 40 h.p. As long as 12 years ago U.S. Motors offered its 50 h.p. model—then 60, 75 h.p.—and now 100 h.p. This leadership in design ability serves you, whatever VARIDRIVE you select, with special U.S. benefit features from the ¼ h.p. model up!

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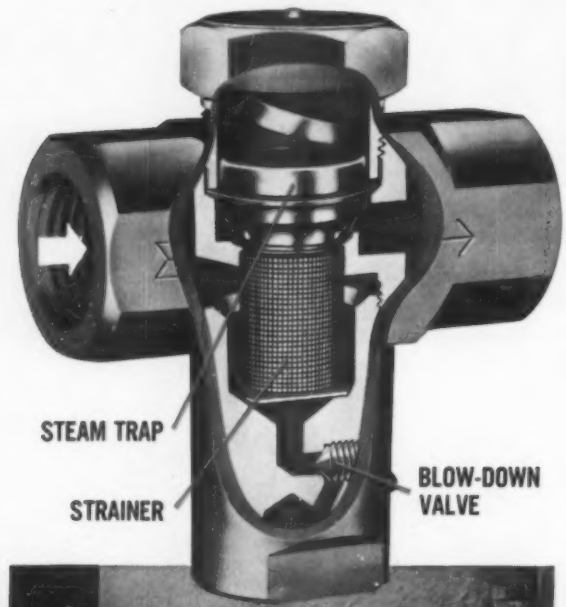
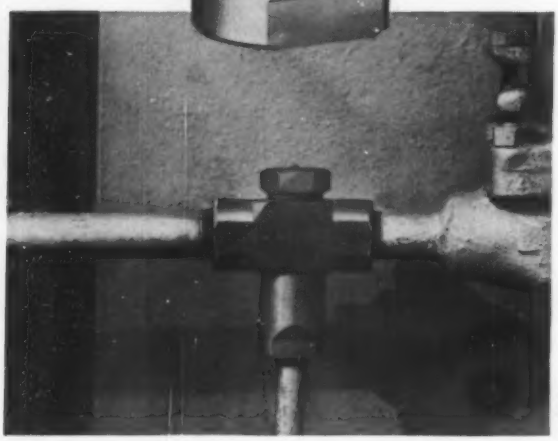
YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD
STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS

3 REASONS WHY NEW YARWAY SERIES 130 IMPULSE STEAM TRAP SCORES BIG SUCCESS





This new Yarway all-in-one combination steam trap, strainer and blow-down valve—designed especially for moderate condensate load applications—is winning enthusiastic approval from users everywhere. Here's why:

it saves space

Entire trapping hook-up can fit into an area no larger than a "T" fitting. Straight-through piping, cleaner installations, more accessibility.

it saves money

Only one unit to buy—plus much lower installation and maintenance costs—results in large savings over conventional trap installations. A fair estimate—*UP TO 30% IN TIME AND MATERIALS!*

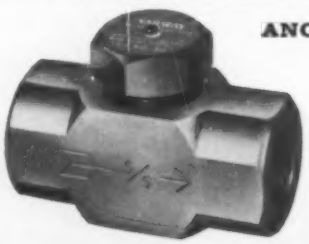
it saves work

No more installation headaches. As easy and quick to install as a pipe fitting. Maintenance is a breeze. Blow-down valve is operated by simple Allen wrench.

SERIES 130 traps are good for all pressures 8 to 600 psi, stainless steel throughout, have replaceable trap valve and seat, woven stainless steel strainer.

Why not try this compact combination on a steam main drip, tracer line or other moderate load application in *your* plant? Your nearby Yarway distributor can now supply you. For more details on Yarway Series 130 traps, write for Bulletin T-1743B.

Yarway Series 130 Impulse Steam Trap draining drip on 700 ft. house heating line at Eddystone Station of Philadelphia Electric Co. Pressure 150 psi; temperature 385° F.



ANOTHER POPULAR YARWAY IMPULSE STEAM TRAP—SERIES 30

This is the "trap" part of the Series 130 described above—but without combined strainer and blow-down valve. Gives peak efficiency on moderate condensate load applications. Offers these features:

- Economy of operation, with close condensate control
- Long service life, with lever action reducing impact in valve seat
- Low maintenance; easily replaceable seat and disc
- High quality, all stainless steel—with a new *low cost*

Write for Yarway Bulletin T-1743.

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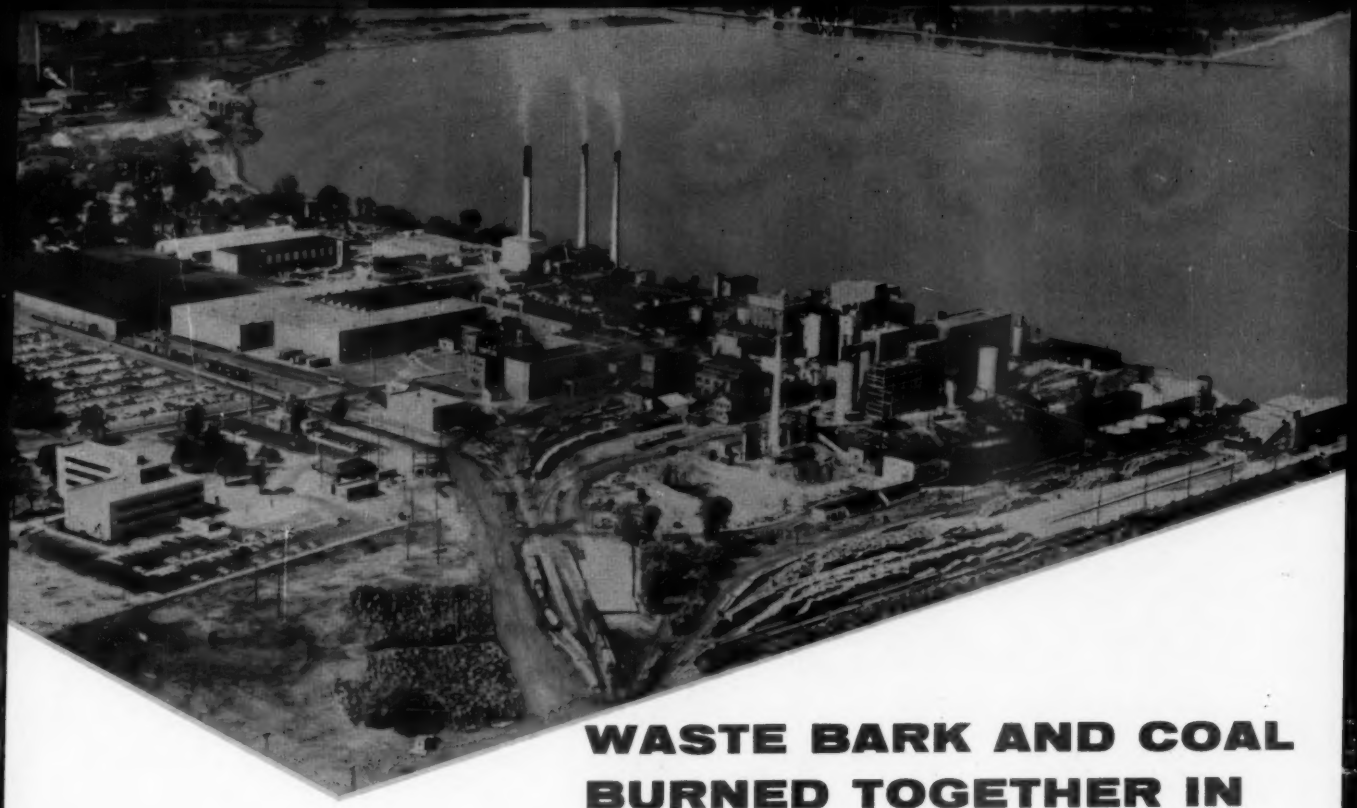


WASTE BARK AND COAL BURNED TOGETHER IN PAPER MILL BOILER

Clyde O. Bitting, Supt. of Power, Hammermill Paper Co., describes unusual boiler control system

EXPANDING REQUIREMENTS for steam in the Erie, Pa., mill of Hammermill Paper Company made a new boiler necessary. For maximum economy, it was desired to burn waste bark and coal together. Power engineers solved this unusual problem by developing an original boiler control system which provides maximum availability at minimum steam costs.

Plant boilers provide the steam required for operating a mill with a production capacity of 240 million pounds of paper annually, produced by seven paper-making machines. The new boiler normally delivers 200,000 pounds of steam per hour at 675 psig and 760 F to the common header.

Up to 80 per cent of the fuel for the new boiler may be bark from pulpwood. More than 40,000 pounds per hour of this waste product could be available for use as fuel. The other 20 per cent of the fuel would be coal, strip-mined within trucking distance, and used alone as fuel for the other boilers.

Engineering studies indicated that the available bark, with slightly more than 50 per cent moisture content, could produce at least 120,000 pounds of steam per hour in proper combination with another fuel. The bark is hogged at the point of production, more than 1800 feet from the boiler. This permits the most economical transportation, pneumatically through an elevated pipeline to the bark distributor.

Highest efficiency is achieved with a spreader stoker for coal and a pneumatic distributor for bark chips. Over-fire air is controlled by a manual loading station on the central control panel.

FOUR STANDARDS. Combustion control system was furnished by Blaw-Knox Company, Copes-Vulcan Division, Erie, Pa. It was designed to:

1. Provide automatic adjustments for variations in fuel moisture, fuel quality, and kind of fuel.
2. Minimize excess air flow for all fuel-flow variations.
3. Minimize air flow through the grate (about 85 per cent of the total).
4. Permit the new boiler to carry base load or major increment of all station loadings.

Control system is designed to maintain a fixed boiler load, as established by the panel-mounted manual-loading station, when other boilers in the plant remain within their control range. If load requirements become more or less than the range permits, an existing plant master controller overrides the fixed load setting, permitting the new boiler, a Riley Type RX-34 steam generator, to increase or decrease the total load further (see drawing). Normally the load set-point signal is reproduced 1-to-1 by the master combining relay. Fully-automatic combustion control is maintained from a normal 200,000 pounds per hour down to 100,000 pounds per hour. It could handle a 10-to-1 turndown.

Air-flow control is maintained by a pneumatic signal from the existing master controller, brought to Port A of the master combining relay, shown in the schematic drawing, and through a combination of high and low-pressure selectors, to Port C of the relay. The master signal is selected by both selectors, and signals to Ports A and C are

equal as long as the master signal remains between 5 and 20 psi. The output from the master combining relay will not change.

In this combining relay the A-to-C ratio is 1-to-1, and the P-to-A ratio is 2-to-1. The boiler transfers automatically from fixed-load control to plant master control when the master signal is outside the 5-to-20-psi range.

The combining-relay output, changed in proportion to any change in the master-control signal, goes through the auto-manual bias-cascade station to Port 2 of the air-flow controller and is balanced by the air-flow transmitter signal that is sent to Port 1. An unbalance of these two signals will vary the controller output signal to the forced-draft-damper drive unit.

Stoker speed is controlled by the air-flow signal when in the fixed-load band. Repeated by a derivative relay, this signal goes to the auto-manual ratio-cascade station, providing the set-point for the stoker-speed controller. It is balanced by the output signal from the steam-flow transmitter to this station.

When in the throttling band, the derivative relay introduces the master signal into the fuel circuit in anticipatory form. This maintains a parallel relationship between fuel and air during periods of load changes.

The boiler can be base-loaded by means of the manual-loading station. This station sends a signal to Port B of the combining relay. Since the ratio of B to C, which equals output, is 1-to-1, the boiler loading will be exactly proportional to the output from the manual-loading station.

INDUCED DRAFT is controlled by a signal proportional to the furnace pressure sent by the furnace-pressure transmitter to Port 1 of the pressure controller. The control point for this signal is determined by the manually-established value at the auto-manual set-point station and sent to Port 2 of the controller. While the two signals are equal, the pressure controller remains in balance and furnace pressure is at the set-point. A change in furnace pressure will upset this balance and cause the controller to increase the output signal. This positions the induced-draft-damper drive unit to restore furnace pressure to the set-point.

Pressure drop across the induced-draft fan is measured by a differential-pressure switch. Normally-open contacts close on falling pressure to energize two solenoids. One solenoid dumps air from the induced-draft-damper drive unit, thus opening the damper wide. The other dumps air from the forced-draft-damper drive unit, and thus closes this damper.

A second differential-pressure switch measures the pressure drop across the forced-draft fan. Its preset contacts close on falling pressure. If the forced-draft fan is lost, the pressure switch would energize the solenoid downstream from the one used to dump air from the forced-draft-damper drive unit. When the downstream solenoid is energized, it feeds full supply pressure to the forced-draft-damper drive unit, stroking the damper wide open.

Four-way valves in the control circuits of the induced- and forced-draft dampers permit manual operation from the transfer panels in an emergency. Switching the panels from automatic to manual automatically strokes both four-way valves to isolate the solenoid valves. Panel output is then fed directly to the drive units and back to Port 4 in each controller.

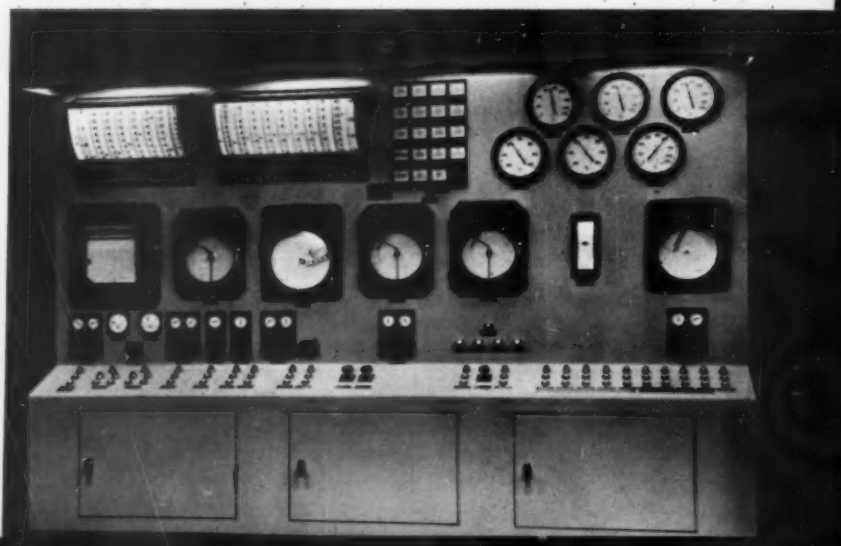
Three-influence feedwater control is provided by balancing steam flow against feedwater flow, and correcting the resultant for drum-level changes. The steam-flow transmitter signal goes to Chamber C of the combining relay, and the water-flow transmitter signal to Chamber A. Output from the combining relay equals the algebraic sum of the two inputs.

When water in the boiler drum is at the desired level and water flow equals steam flow, the combining relay will repeat the level-transmitter output 1-to-1. This will exactly equal the set-point signal, and the system will be in balance.

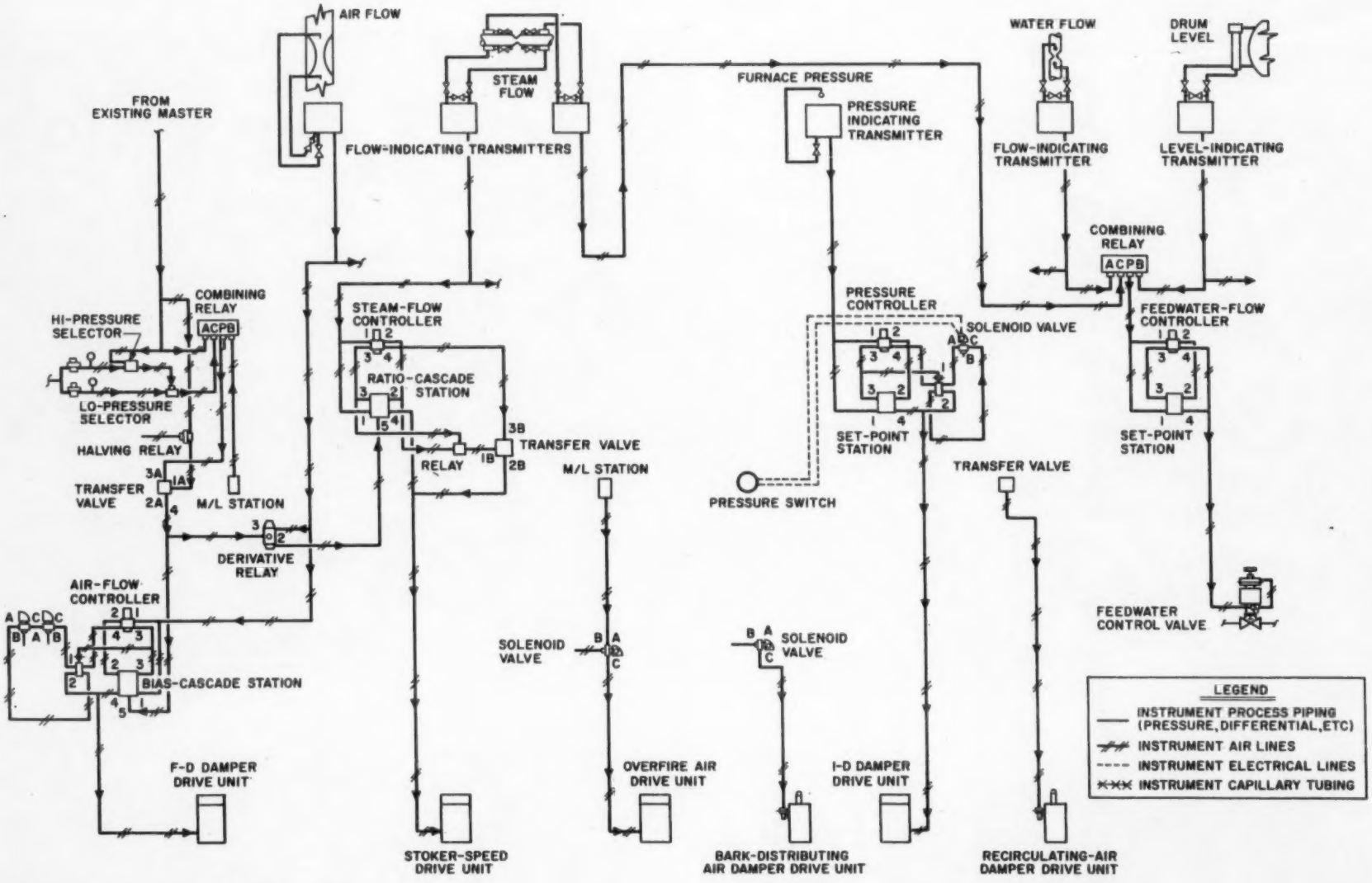
Balance in the flow controller will be upset by any change in signals to A, B, or C, which will change the combining-relay output proportionately. The controller will then send a signal in the direction required to return the transmitted signal to the set-point. In operation, the effects of an increase or decrease in steam flow (Chamber C) will ultimately be cancelled by a corresponding increase or decrease in water flow (Chamber A). For this reason combining-relay output will always return to the original 9-psi set-point.

Steam-temperature is controlled by a Copes-Vulcan system not shown on the schematic drawing. A Transaire steam-temperature transmitter at the superheater outlet actuates a Type CV-D spray-control valve through which cooling water is added to, and mixed thoroughly with, the steam just ahead of the second pass of the superheater.

PERFORMANCE: GOOD. High operating efficiency, expected because of the close control of excess air, has been proved in operation. Over-fire-air demands were expected to vary more widely than has been experienced in boiler operation. Fuel-bed disturbances have been minimized by keeping the air flow through the bed at the lowest practical rate. Intermittent flows of waste fuel have been handled smoothly. Incidentally, uncontrolled total steam temperature tends to run about 30 F higher when bark is burned alone than when coal is burned in combination or alone. The automatic control has proved adequate without manual adjustments for variations in fuel moisture, fuel quality, or kind of fuel.



All recorders and controllers for the bark-and-coal fired boiler are centralized on this panel



Combustion and feedwater control systems

MORE DETAILS OF "PROJECT EHV"

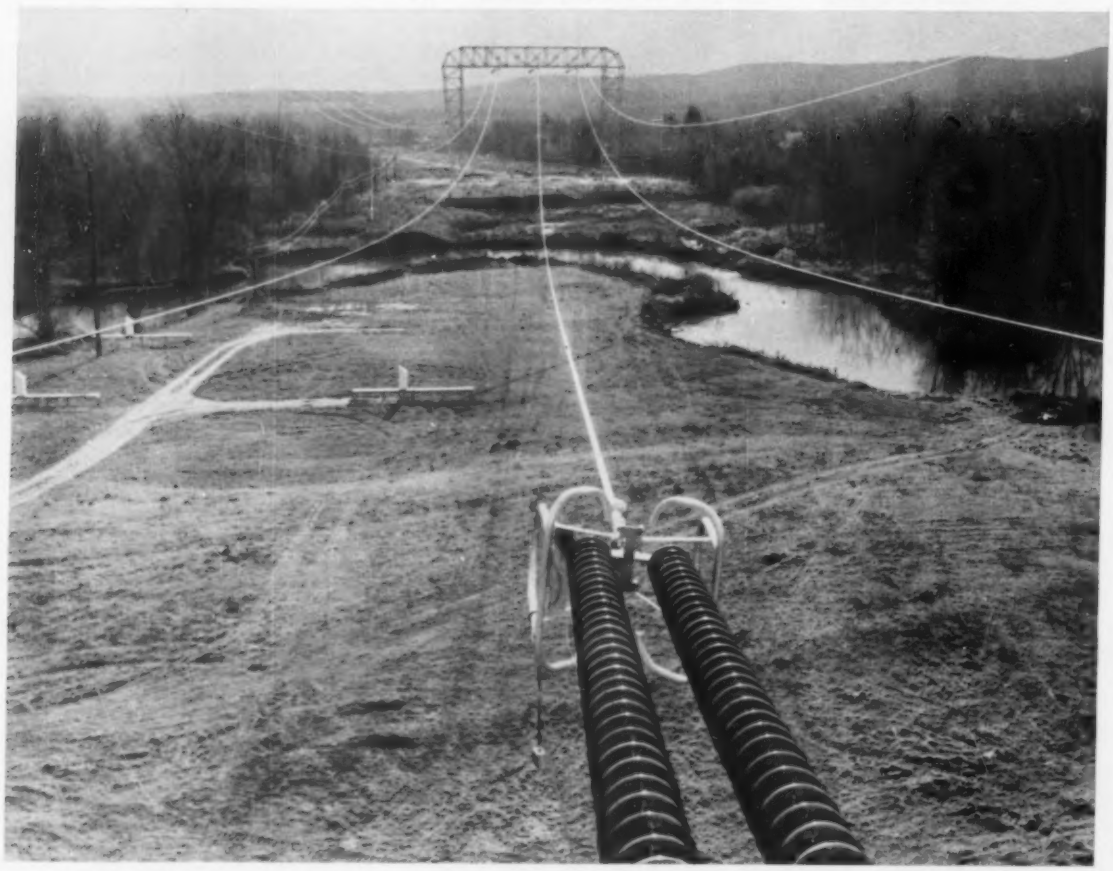
Line specifications and test procedures of the project are discussed in this article

A ONE-LINE SYSTEM DIAGRAM of Project EHV, in its final stage, is shown in Fig. 2; the various numbers correspond to the apparatus. Rating of the most important items is given in Table 1. Four stages of operation are planned:

Stage 1. Since corona loss may be measured only on open-ended lines, at first the system is operated in this manner at 500 kv, with *voltage runs* between 400 and 550 kv. In order to obtain more data in a shorter time, and to study the effect of line length, provision has been made for dividing the line into two parts, by a removable jumper at tower number three (numbered from the North Station). The 0.65-mile *short section* is adjacent to the North Station and comprises three portal-type towers, which facilitate changing of the line configurations without lowering the conductors to the ground.

Variable interphase spacings

Fig. 1. View of Project EHV line, which is operating at 720 kv



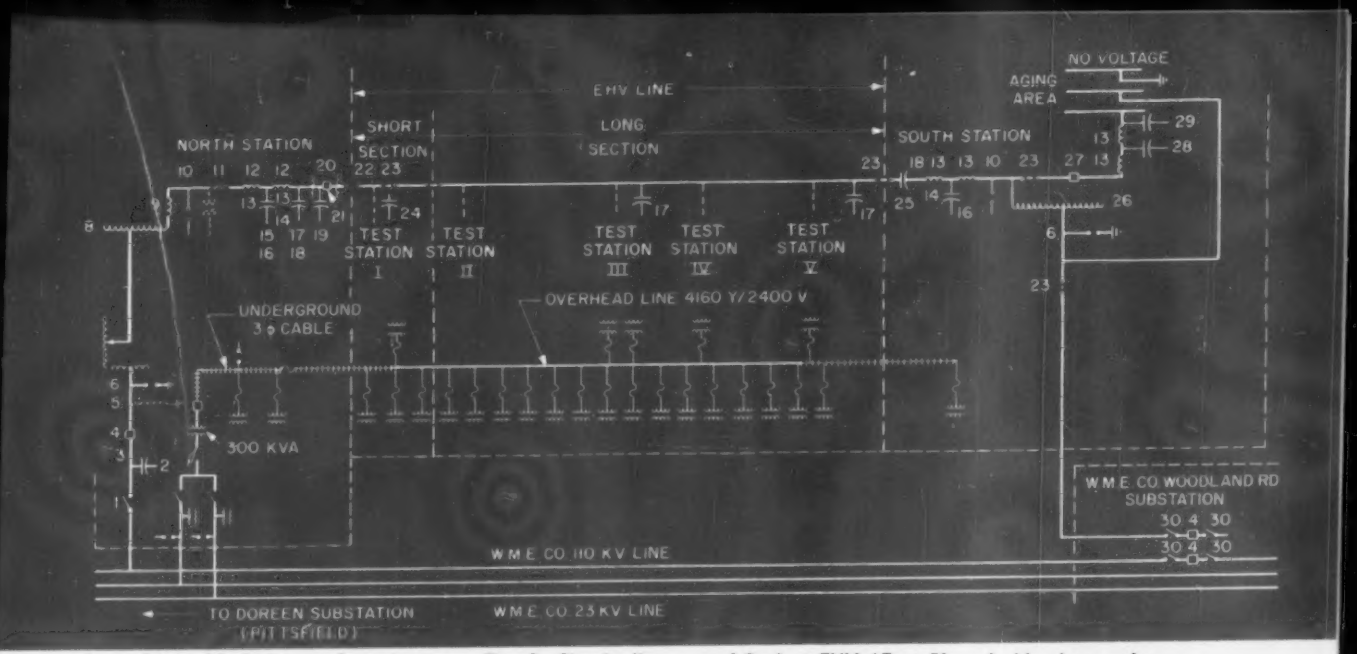


Fig. 2. Circuit diagram of Project EHV (East Phase). Numbers refer to the apparatus, which is listed in Table 1 on the following page

from 20 to 50 feet may be set up. Here configurations will be changed every three months, to study a large number of different conductors and spacings. The 3.65-mile *long section* is adjacent to the South Station and is built with representative towers, designed for maximum economy, just as the utilities would, plus the features required for experimental work.

On this section, only two phase spacings are used — 38.5 feet for 460-500 kv, and 45.5 feet for 650 kv. Here, line configurations will be tested for about one year each, in order to determine aging effects and obtain statistically valid results, over a complete cycle of weather conditions. At certain times, the same configurations will be used on the short and long sections of the line, and therefore three lengths may be investigated: 0.65, 3.65, and 4.30 miles.

Stage 2. The same procedure will be repeated at 650 kv (750 kv maximum).

Stage 3. The EHV system will be operated in parallel with the 115-kv system of Western Massachusetts Electric Company (WME Co.). By changing the settings of the regular and autotransformer taps at both ends, it will be possible to circulate current through the EHV system up to 50,000 kva. Thereby the thermal performance of the apparatus will be investigated, under normal load and overload conditions.

Stage 4. Finally, the air-blast breaker in the Lee Station (on the 115-kv line of WME Co.) will be opened, and Project EHV system will temporarily replace this line and deliver power to Pittsfield. At that time, the entire Project EHV system will be operated and dispatched by WME Co. and, in fact, become an integral part of the New England interconnected system.

By having a utility operate the system, valuable data will be obtained of its performance under actual service conditions. When the last stage of the project is completed in 1963, a decision will be made whether to discontinue testing, or to continue at 650-kv (or higher) a-c voltages, or convert to 2 × 500-kv d-c.

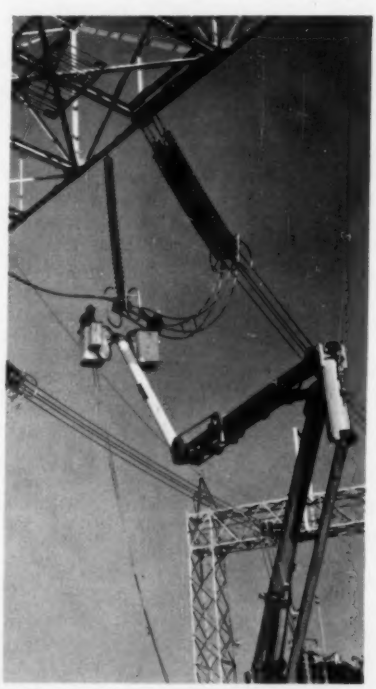


Fig. 3. Terminal connections being made prior to project testing

CONDUCTORS. Conductor sizes and configurations, listed in Table 2, have been determined by taking into account the over-all line economics, the RI level and sleet prevention. The conductor cross section was chosen to have approximately the most economical value for loads somewhat larger than surge-impedance-loading. The detailed economic study, discussed previously, has shown that at 460-500 kv, one, two, or three conductors per phase may correspond to the most economical configuration, depending upon the load, distance, cost data, and other conditions. Therefore, it was decided to use the same cross section for configurations with one, two, and three conductors per phase, and compare the performance of these configurations. Such a test has not been made previously. Four conductors per phase will not be tested for the time being, in order to avoid duplication with the Cold-water project of the Hydroelectric Commission of Ontario.

Conductor diameters were chosen to yield the RI levels indicated in last column of Table 2 at 100 feet from the outer phases. These levels are between those of the Swedish 400-kv lines and of American Electric Power's 345-kv lines. Calcula-

TABLE 1. PROJECT EHV APPARATUS

Item* No.	Description	Rating and Notes	BIL KV
7	Regulating transformer	OA/FA-T-30,000/40,000 (output)—110,000 GrY/63,500—	450
		110,000 GrY/63,500 ±30%, 72 step	550
8	Autotransformer	FOA-T-60-40,000 (output)—650,000 GrY/375,000—	1925
		134,000 GrY/77,400—	550
		Delta,-(4) 1¼ % taps in the 650,000-volt winding	
9	Current transformer	BR-60-1200-5 amp. Transformer will give current information to a transmitter at 194 kc for protection of the heating winding in item No. 8.	
10	Lightning arresters	Rated 516 kv, 9 LA3K516	
12	Line traps	800 A. Tuned to 150 and 1040 kc for the RI measurements.	
15	Coupling capacitors	(5) CW 33. Tuned to 150 and 1040 kc for the RI measurements.	2300
19	Gas-filled (SF_6) capacitor	Type CG. Potential information for the corona loss measurements.	2050
20	Isolation transformer	OA-60-3870-4300-2865. Separates the heating current from charging and corona loss current.	
22	Disconnect switches	1600 A	2050
24	Impulse generator	3200 kv, 250 kw sec.	
25	Series capacitor	10,000 kva, 75 kv series voltage	2050
26	Autotransformer	FOA-T-60-40,000 (output)—650,000 GrY/375,000 or	1925
		460,000 GrY/266,000—	
		110,000 GrY/63,500—	450
		13,200, + (4) taps in 650,000-volt winding (total range 10%), + (4) 1.55% taps in 460,000 winding.	

* (Item numbers refer to those shown in Fig. 2.)

tions showed that ordinary ACSR conductors were adequate for configurations of 2, 3, and 4 conductors per phase, but that an *expanded conductor*, 2.32 inches in diameter, had to be designed for the configuration with single conductors per phase. At 650 kv, only configurations with three and four conductors per phase will be used, because economic studies have shown that twin expanded conductors are too expensive, and single expanded conductors are impractical.

As may be seen from Table 2, the same conductors will be used for the multiple configurations at 460-500 and 650 kv. This will permit studying long-term aging, by rearranging the conductors. For instance, after the 500-kv tests have been completed, six aged Plover (1.465 in.) conductors will be available. These will be rearranged into two phases, of three conductors each, for 650 kv. The third (outer) phase will consist of new conductors from the same shipment. By comparing the RI level of the two outer phases, it will be possible to determine the effect on RI of pre-aging the line at 500 kv.

This procedure may also present practical advantages for utilities which wish to build an extra-high-voltage line, and operate it first at a lower voltage with fewer conductors per phase. A portion of the initial investment is thus deferred, but the problems of different electrical and mechanical aging of the conductors must be solved.

SPACINGS BETWEEN PHASES indicated in Table 2 are used. It is recognized that 20 feet at 460-500 kv, and 38.5 feet at 650 kv, may be too low, but it is desired to ascertain what is the smallest spacing consistent with acceptable service. Spacing between conductors in the bundle will be maintained at 18 inches for all cases. This is about the best compromise between corona loss and RI requirements on one hand, and surge-impedance and mechanical requirements on the other hand.

Many theoretical and experimental investigations have been made of this particular subject, and there is no need to repeat them. However, 10-inch spacing, corresponding to minimum RI level, is used for the strain buses at the South Station, in order to minimize all RI generated outside the line itself. For the same reason the North Station buses consist of 4½ in. OD aluminum tubing, and the separation between phases is 35 feet.

Strings of 22 high-strength (36,000 lb) 5¾ × 10 in. Locke insulators are used for 500 kv, and of 30 insulators for 650 kv. For 460-500 kv, the *station* BIL is 1425 kv, and the *line* BIL 1550 kv; for 650 kv, the *station* BIL is 1925 kv, and the *line* BIL 2050 kv. It will be noted that the station BIL thus chosen are proportionately lower than the BIL of operating 345-kv and 400-kv systems.

This is in line with modern American trends, wherein the improved protective characteristics of r cent arresters permit considerable saving by reducing the BIL of the transformers and other station equipment. The number of line insulators was chosen after the predetermination of the lightning performance of the line by geometrical models, and on the basis that, with the new American air-blast breakers, the switching-surge overvoltage level would not exceed 2.5 times the power-frequency line-to-ground voltage.

Editor's note: In a later issue Dr. Abetti continues this story on "Project EHV," in a discussion of towers, research objectives and the conclusions drawn from the project up to the present time. END

TABLE 2. CONDUCTOR CONFIGURATIONS

Rated Voltage	460 kv	460 kv	500 kv	650 kv	650 kv
Conductors/phase	1	2	3	3	4
Name	Special	Plover	Cardinal	Plover	Cardinal
OD (Inches)	2.32	1.465	1.196	1.465	1.196
Total MCM/phase	2925	2862	2862	4293	3816
Interphase spacing (ft)					
Short section	38.5	20, 30, 38.5	38.5	38.5, 45.5	45.5, 50
Long section		38.5		45.5	45.5
Intraphase spacing (in.)	18	18	18	18	18
Surge impedance** Ω	381	303	279	285	270
SIL* (Mva)	556	686	758	1482	1566
RI level (μV/meter @ 100 ft)	70	41	31	73	52

* SIL: Surge Impedance Loading.
** For 38.5-ft spacing @ 460-500 kv, and 45.5-ft @ 650 kv.

Chmn. R. A. Gallagher (3rd from left) and friends (l-r) Msgr. J. H. Jansen, St. Mary's Catholic Church; Pres. C. H. Blanchar; and Allis-Chalmers Pres. R. S. Stevenson meet at station entrance

DEDICATE

ROBERT A. GALLAGHER STATION

Puts Public Service Co. of Indiana's capability 33 per cent over peak 1961 customer demand

FORMAL DEDICATION ceremonies of the 600-Mw Robert A. Gallagher generating station at New Albany, Indiana, June 20 marked completion of an important phase of Public Service Co. of Indiana's ten-year expansion program. During this period, the company built three new stations, installed a 500-mile, 230-kv transmission system, doubled its 132-kv mileage and heavily increased its distribution facilities.

The station brings the company's total capability to 1640 Mw—33 per cent over the highest customer demand expected this year. This capability is almost four times that of ten years ago.

In accepting a bronze portrait plaque unveiled in his honor, Chairman and Chief Executive Officer Robert A. Gallagher mentioned that in the last decade the company invested $393 million, or 77 per cent of the company's total investment of $509 million in plant facilities as of December 31, 1960. By 1965, an additional $135 million is expected to be invested.

DISPATCHED FROM company headquarters at Plainfield, Indiana, through carrier current, microwave and leased telephone lines, the station's four 150-Mw units each operate at 1850 psi, 1000 F/1000 F. Net designed station heat rate is 9487 Btu/hr.

Future units will range from 200-500 Mw, according to Joseph J. Trainor, vice-president, technical development. However, as a result of interconnected-company studies, a 1000-Mw unit may be built.

Electric auxiliary supply is at 4.16 kv and 440 v. About six per cent of station capacity is required for auxiliaries.

Main power transformers step the 18-kv generator output up to 132 kv and 230 kv to tie into the system through two separate switchyards.

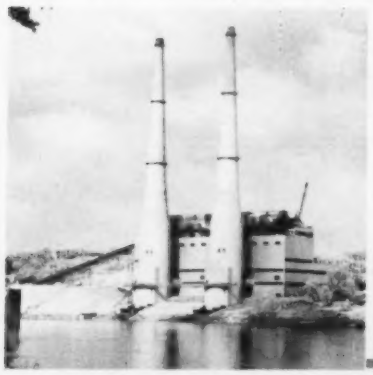
The Riley boilers are each 155-ft high and handle 1,000,000 lb of steam per hour and can use 4.08 tons of coal per hour. Mechanical precipitators remove 85 per cent of the flyash, and Apra prceipitators operating at —15 kv and using 6400 3-in. OD dust-charging tubes per boiler take dust removal to 98.5 per cent of the 652,000 cfm of flue gas.

Stacks are 550-ft high, 68-ft diam at base, tapering to 15.5 ft. Bottom walls are 4-ft thick; 10,000 cu yd of concrete were used in construction. Interiors are lined with 200,000 bricks.

The plant is protected by a central CO_2 system whose 12,000-lb storage tank is kept at 0 F. The system purges the generators' hydrogen coolant when necessary.

Condensers operate normally at 2-in. Hg back-pressure and handle 75,700 gpm of river water. Rotating debris screens are 95-ft long and 9-ft wide and move at 2.5 ft/min rate. END

Water treatment and other equipment is inside stacks on four levels



POSITIVE CONDENSER LEAK DETECTION

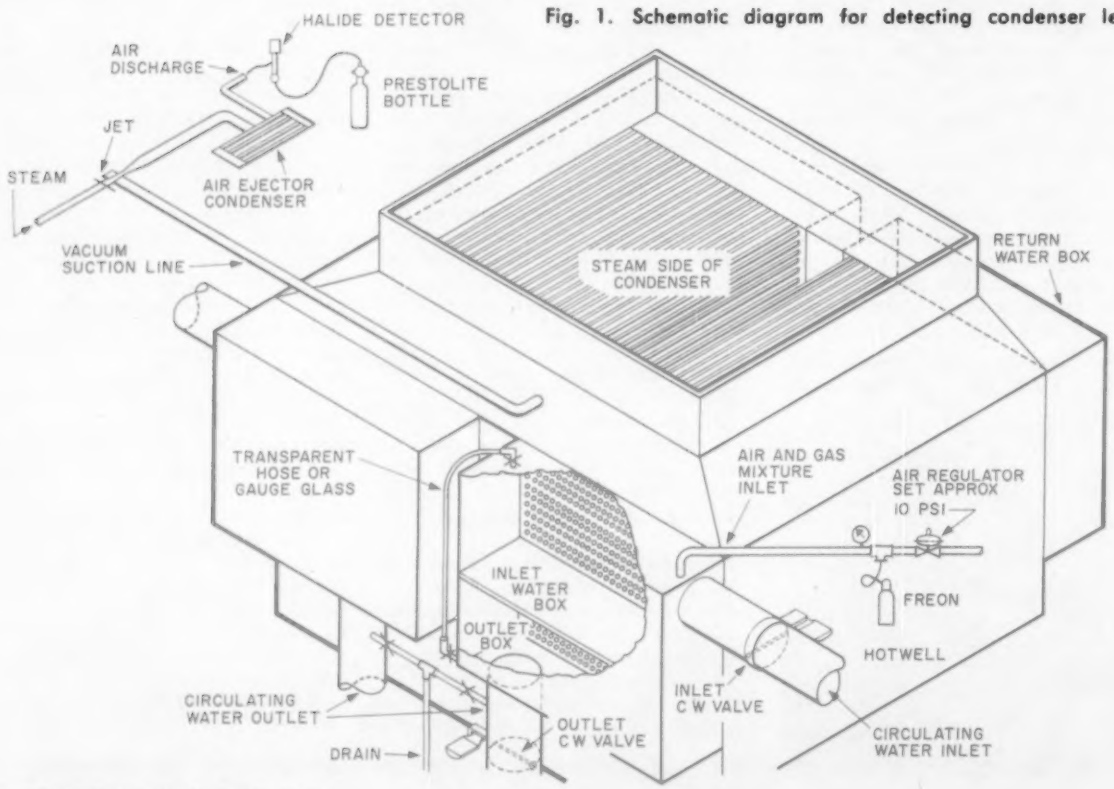
Ed Mitchell and V. I. Johnson, of Oklahoma Gas & Electric, explain how to find condenser leak

AS THE TREND CONTINUES toward the use of boilers of higher and higher pressure, many new design and operating problems must be met. Not the least of these is the necessity of preventing impure water from any source entering the boiler or feedwater system. There have been instances where much damage has resulted from the introduction into the feedwater system of even a relatively small amount of water containing high concentrations of impurities. Abnormally high total solids in the boiler water causes foaming and carry-over. If the unit is not immediately taken out of service, blade deposits, sticky control valves, and tube failures, early or delayed, will result.

One of the most common sources of contamination of the boiler water is from circulating water entering the system through leaks in condenser tubes. Finding leaks in condenser tubing can be a very difficult and time-consuming job. Several methods have been resorted to with varying degrees of success.

Recently on a 150-Mw, 1800-psi, 1000 F unit we noticed a gradual buildup of silica in the boiler water which necessitated frequent blowdowns. All the various sources of possible contamination were checked and scores of water tests were made in an effort to locate the source of the silica. Curves were plotted showing silica concentration on the boiler water, kilowatt load, blowdown, river elevation, and water table elevations. It was noticed that the increase in boiler silica coincided with the rises in river elevation. It was

Fig. 1. Schematic diagram for detecting condenser leaks



at first assumed that river water, which at times showed 15-ppm colloidal silica, was seeping back into our wells, which were used as make-up water to the demineralizer; however none or very little colloidal silica could be found in the well samples.

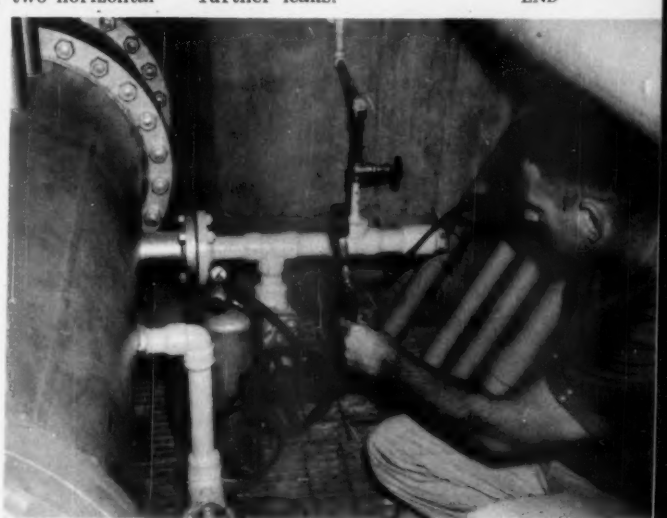
In going over the conductivity charts it was noticed that at certain times, coinciding with an increase in boiler silica, the hotwell conductivity rose sharply from a normal value of about 0.2 mmho to perhaps 1.5 or 2.0 mmho and gradually came back down. This led to the conclusion that during periods of higher river elevation the condenser differential pressure increased sufficiently to open the tube leak. Decision was made to simulate this higher differential pressure so that the leak might be detected.

METHODOLOGY. Load was dropped to 60 Mw and first one side of the condenser was cut out and then the other, during which time the hotwell conductivity was carefully observed. Water box pressure was increased to about 10 psi by throttling the discharge valves. In this way it was determined which section of the condenser was leaking. With the water boxes full to the vents, an air hose was attached to a top vent for the purpose of maintaining about 10-psig pressure on the water side, Fig. 1. Since the unit was still in service, this meant a differential pressure of about 24 psi on the condenser tubes. A connection was also provided for introducing Freon gas into the condenser along with air. In this case 3 one-pint cans of Freon were used, the condenser section having 40,000 sq ft of surface area.

Four men were used in the test. One man operated the drain valve, one watched the condenser water level by means of a clear Tygon tube attached to top and bottom connections, one regulated the air pressure and introduced the Freon gas, and the fourth man was stationed at the air discharge from the air ejector with a Halide detector. As soon as the water in the condenser reached the level of the cracked tube, air and Freon gas escaped into the steam side, where it was sampled by the air ejector and immediately indicated by the change in flame color from blue to green in the Halide detector. This point of water level was marked on the condenser, water was drained out, and water box doors opened.

It was known that the leak should be confined to one or two horizontal rows of tubes across the condenser immediately above the water line at the instant of leak detection. This proved to be correct, and the leaky tube was readily found and plugged. Two men entered the water boxes at each end with 2-foot sections of clear plastic Saran wrap. By slowly moving the plastic over the tube sheets on both ends of the condenser, a seal was made on the tubes, and the plastic was drawn into the leaking tube.

CONCLUSIONS. This is one of the most positive and convenient methods of condenser leak detection that we have found. By means of the higher differential pressure it is possible to make small cracks open enough to be detected. Of course when the first leak is found it will be necessary to plug the tube and allow sufficient time for all the Freon in the condenser to be evacuated before proceeding to check for further leaks. END



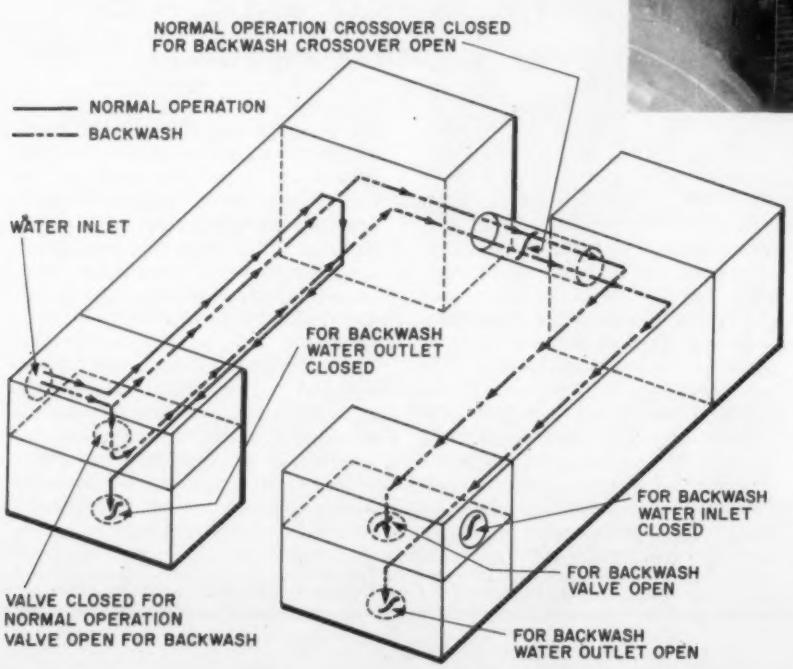


Fig. 2. Ed Mitchell holds Halide feeler hose in end of gas discharge line from air ejector. Fig. 3. Schemmatic drawing for backwash for two-pass double-flow condenser

NUCLEAR REACTOR INSTRUMENTATION IS NECESSARILY COMPLEX

A. Dahlinger, Supt., Maint. and Power Branch, Atomic Energy of Canada Ltd., analyzes Chalk River system

NO INDUSTRY TODAY can operate efficiently without using instruments to monitor and to control its process variables, but a nuclear reactor is particularly dependent upon them. Nuclear reaction rates, for example, are high, and the hazards consequent upon an accident that may release radioactive contaminants are great. Speed and accuracy of monitoring and control are, therefore, absolutely essential to safe efficient operation of nuclear reactors, and only good instrumentation and lots of it can achieve this goal. Automatic control of reactors by instruments is more than just the best way to do it — it is the only possible way to do it.

A nuclear reactor is not a simple system, but a complex of many systems, each of which requires its own instrumentation. The front cover of this issue, for example, shows some of the differential pressure cells used to measure the flow of heavy water coolant through the fuel rods in the NRU reactor at Chalk River. There are some 300 rod positions in NRU, each of which is instrumented as a separate system.

As well as these, there are the heavy-water moderator, light-water cooling and instrument air circuits, and purification systems for heavy water and helium used in the reactor. A great many instruments are required to monitor and control all these systems; so many that the statistical number of instrument failures one could expect would result in a prohibitive number of false alarms which shut down the reactor. Simply putting instruments wherever needed defeats itself.

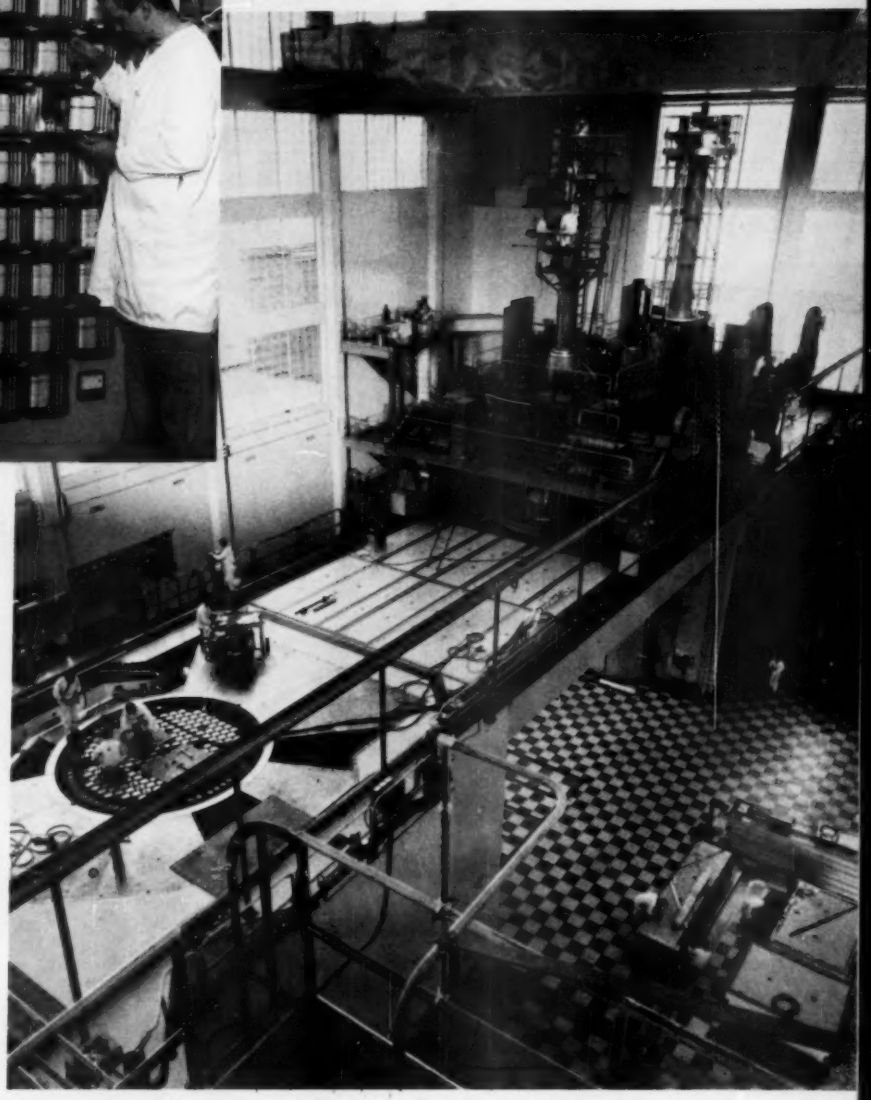
TRIPLICATION is the answer to the problem: all important instruments, that is to say, all instruments that have to do with the safety and control of the NRU reactor are triplicated, and two of any triplet must alarm together to shut down the reactor.

At first sight triplication of instruments seems an expensive and

ATOMICS

Rod flow recorder panel uses 3-pen type recorders. Arrangement corresponds to actual rod positions in reactor

NRU's 200-Mw (thermal) natural-uranium heavy-water-moderated research reactor produces plutonium and radioactive isotopes



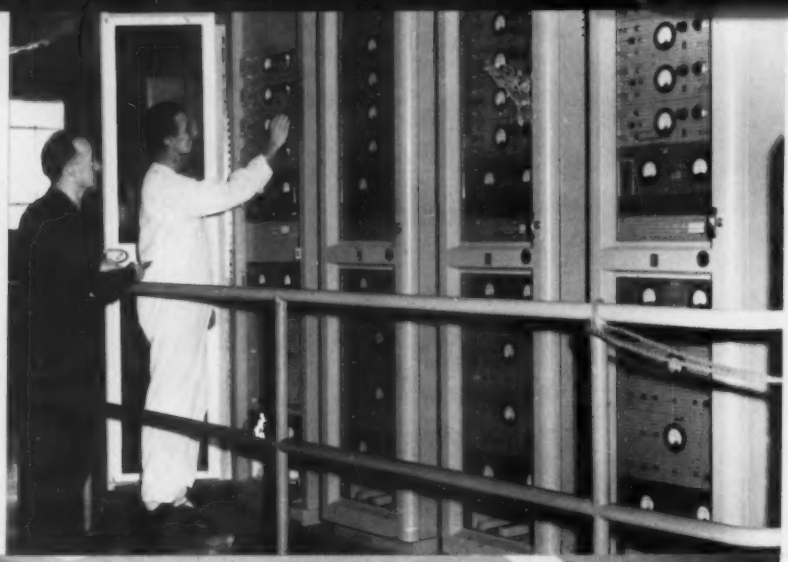
burdensome penalty, but in practice it pays some unexpected dividends. Triplication does, of course, what it was intended to do: by identifying false alarms caused by instrument failures it eliminates unnecessary—and costly—shutdowns. But it also enables the instrument men to service and repair instruments while the reactor is operating. It is no longer necessary to wait for shutdowns to maintain and inspect instruments. To be able to service instruments during operation is a great help, because the serviced instrument can be immediately checked and calibrated at operating conditions against the others in the triplet. And as a final dividend, an instrument that begins to wander is at once evident and can be serviced before it fails completely. Triplication of instruments in NRU has been well worth the price.

All the usual variables measured and recorded in any process, such as temperatures, flows, and pressures, are measured in NRU, but as well as these, radioactivity is monitored and reactor power is measured and controlled. Radioactivity and reactor power require instruments not common to other industries. Reactor power, for example, is measured by counting neutrons in ion chambers, and using the amplified signals to give the log of the power, the log of the rate of change of power, the linear change of power, and the linear rate of change of power. Although these instruments add complication, they also give a touch of elegance to the system that no instrument man can fail to be proud of.

Clearly the instrumentation of a nuclear reactor is complex and various, and there is lots of it. To give some numbers, instruments in the NRU reactor include the following:

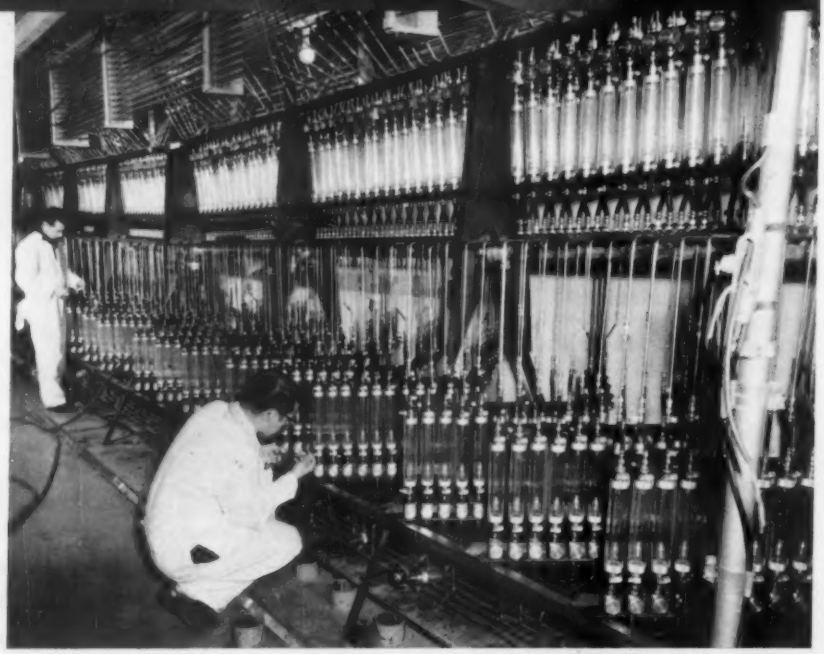
1.	Major devices — transmitters, recorders, primary elements	2600
2.	Pressure gages—includes contacting gages	775
3.	Indicating flow devices—flowrators, ratosights	1040
4.	Pressure switches — blind types	915
5.	Nuclear radiation devices —electronic amplifiers	700
	Total	6030

Reactor automatic power control system is in four channels and two of the four must show a fault to shut down reactor



NRU main control room instrumentation is made elegant by radioactivity and reactor power measuring devices. Radiation is measured far right

Over 600 flowmeters measure heavy water flow to the rod activity monitors



START IOWA 161-KV LINES FOR MISSOURI RIVER BASIN

D. L. Goodman, Engineer, Bureau of Reclamation, Denver, describes design of Bureau's two new lines

CONSTRUCTION BEGAN in April on two Bureau of Reclamation transmission lines in western Iowa, the first to be undertaken by the Bureau in that state. They are part of the Missouri River Basin Project and extend 67 miles northeast from Sioux City substation near Hinton, to Spencer, and from Hinton 146 miles southeast through Denison to Creston. (See map, Fig. 1.)

The two lines are of 161-kv, three-

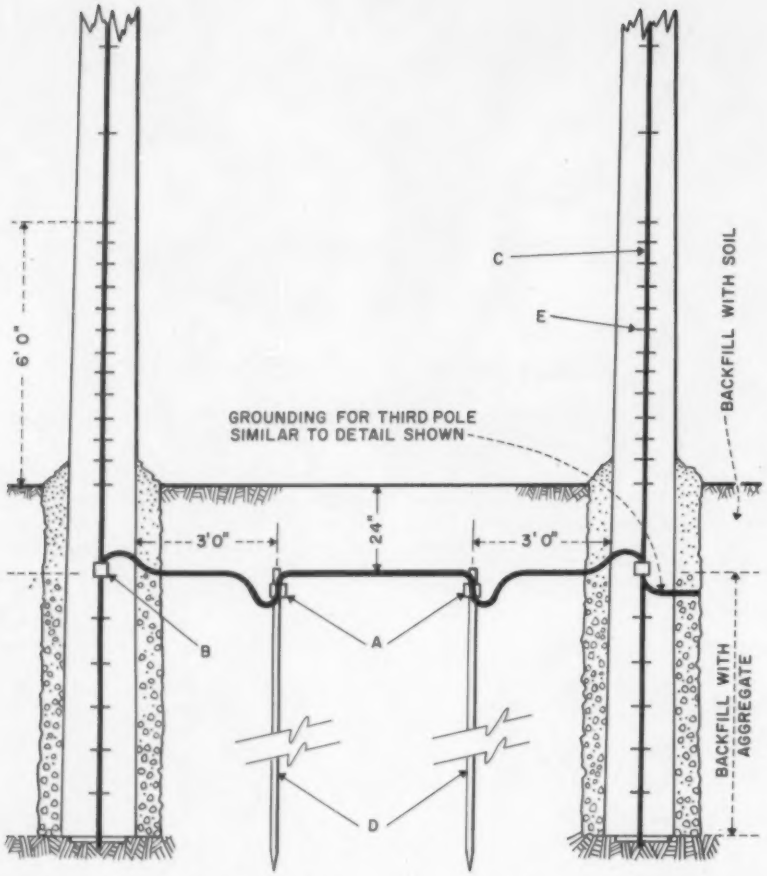


Fig. 2. Grounding and backfill details for construction of tangent suspension structure show how the aggregate is installed

Part	Material Required
A	Clamp, copper alloy, ground wire to ⅝-inch rod
B	Clamp, parallel groove, 2-bolt, copper alloy or copper
C	No. 2 AWG, 30% conductivity copperweld wire
D	Ground rod, copperweld ⅝ inch by 8 feet 0 inches
E	Copperweld staples, 0.144 min. diam. of wire 1¾ inches long, ⅝-inch opening

phase, wood-pole H-frame, single-circuit construction, and are designed for NESC heavy loading conditions. Structure height varies from 55 to 80 ft. Conductors on the Sioux City-Spencer lines and the Sioux City-Denison section will be 954 MCM ACSR. The Denison-Creston section conductor will be 556 MCM ACSR. Both lines will be protected by two ⅜-in. galvanized steel strand overhead ground wires.

The first two structures out of Sioux City substation will be double-circuit steel towers and will carry both lines from the substation. The 121-ft high towers are necessary to clear a nearby highway. Their erection is expected by November.

Both lines cross rich agricultural areas where corn grows as high as 16 ft. The Sioux City-Denison-Creston line crosses an area of comparatively dense farming and rolling hills. A large number of relatively deep wooded gullies traverse the area of rolling hills.

Fences and utility, highway and railroad crossings average about six per mile. The Sioux City-Spencer line traverses relatively flat terrain, all of which is farmed. Right-of-way widths are about 100 ft.

To obviate the necessity for guying suspension-type structures for small line angles up to four degrees, which would interfere with cultivation of adjacent fields, a special type of three-pole structure was specified. (See Fig. 3.)

To prevent poles in the H-frame structures from "walking" out of the ground from transverse winds, the specifications call for gravel fill around the poles to provide lateral stability. This is a novel design requirement for Bureau transmission line work. (See Fig. 2.)

All pole holes are to be dug at least 12 inches larger in diameter than the greatest diameter of the pole butts to provide space for gravel backfill. The gravel is to be vibrated in place in the holes. The upper two feet of each hole is to be backfilled with soil excavated from the pole holes and will be compacted by tamping.

In poor soil areas, specifications call for bog shoes to provide suitable bases to support some of the angle structure poles. The bog shoes are to be at least six feet long and eight inches in diameter and are to have the same preservative treatment as the poles. The bog anchors are to be of reinforced concrete at least six feet long and eight inches in diameter.

VHF RADIO FACILITIES will be installed by the Bureau's field forces to provide mobile coverage of the lines during construction and later for operation and maintenance purposes. The facilities will include four VHF radio relay stations at Sioux Falls, South Dakota, and at Le Mares, Charter Oak, and Exira, Iowa. An existing relay station at Arlington, South Dakota, will be modified, and three new base stations will be established at Spencer, Denison, and Creston.

Six steel antenna towers and six prefabricated metal buildings are required for the radio system.

SUBSTATIONS. As construction proceeds on the two lines, work is underway at the four substation terminals.

Current modifications of Sioux City's substation (built in 1955 and enlarged in 1958) include installation of two 230- to 154-kv 75/100/125-Mva and one 154- to 69-kv 45/60/75-Mva autotransformers plus lightning arresters, and a bank of three 4-Mva shunt reactors. The additions also include one complete 230-kv bay for terminating a new line from Fort Randall power plant; a new 161-kv switchyard consisting of seven switching bays for terminating lines to Iowa Public Service Co., Denison, and Creston and for connecting to the three transformers; one 69-kv bay for connecting to

the 154- to 69-kv transformer; and one 15-kv structure for switching the shunt reactors.

The substations at Spencer, Denison, and Creston are new. Their equipment includes a 36/48/60-mva autotransformer at Spencer; two 30/40/50-Mva autotransformers and one 75/100-Mva voltage-regulating transformer at Denison; and one 30/40/50-Mva autotransformer and one 37.5/50-Mva voltage-regulating transformer at Creston. One 161-kv and one 69-kv duplex control boards are under contract to be installed in Creston and Spencer substations, and one 161-, 69-, and 13.8-kv duplex control board is to be installed in Denison substation. One 161-kv and one 230-kv control board sections and synchronizing panel and one master controlling switchboard are being installed in Sioux City substation. A remote station supervisory control and telemetering switchboard is being installed in each of the three new substations.

INTERCONNECTION will be made with the Bureau's Transmission Division of the Missouri River Basin Project. Power will be supplied by the Corps of Engineers hydro plants on the main stem of the Missouri River as part of the integrated project power system — Fort Peck in Montana, Fort Randall and Gavins Point in South Dakota, and Garrison in North Dakota. Additional power will be made available later when the Oahe and Big Bend plants in South Dakota are completed by the Corps.

The Transmission Division embraces Nebraska, North and South Dakota, and parts of Colorado, Montana, Wyoming, Minnesota and Iowa. Transmission facilities of the project interconnect and coordinate the operation of Bureau of Reclamation and Corps of Engineers hydro plants in the Missouri River Basin and deliver power for irrigation pumping and sales to municipalities, cooperatives, private utilities, and other wholesale customers.

The two new lines are to supplement power to several large municipal utilities and rural electric cooperatives in western Iowa, which now are supplied power from steam and diesel generating plants in the area. The power is to be sold to the utilities and cooperatives under marketing criteria and rates established by the Bureau of Reclamation for the project power market area.

Initially, 87,000 kw will be made available to the utilities and cooperatives from the integrated project power system. Ultimately, greater amounts of power will be transmitted through the two transmission lines when additional power allocations are made from the interconnected Missouri River Basin Project system. Consideration is being given to interconnection of the two lines with private utilities in the area for the exchange of power under certain normal and emergency operating conditions.

The Hoak Construction Co. of West Des Moines, Iowa, holds the $3,335,242 contract for line construction. Under contract terms, the Sioux City-Spencer line and the Sioux City-Denison section is to be completed by May 1962. The Denison-Creston section is to be completed by September 1962.

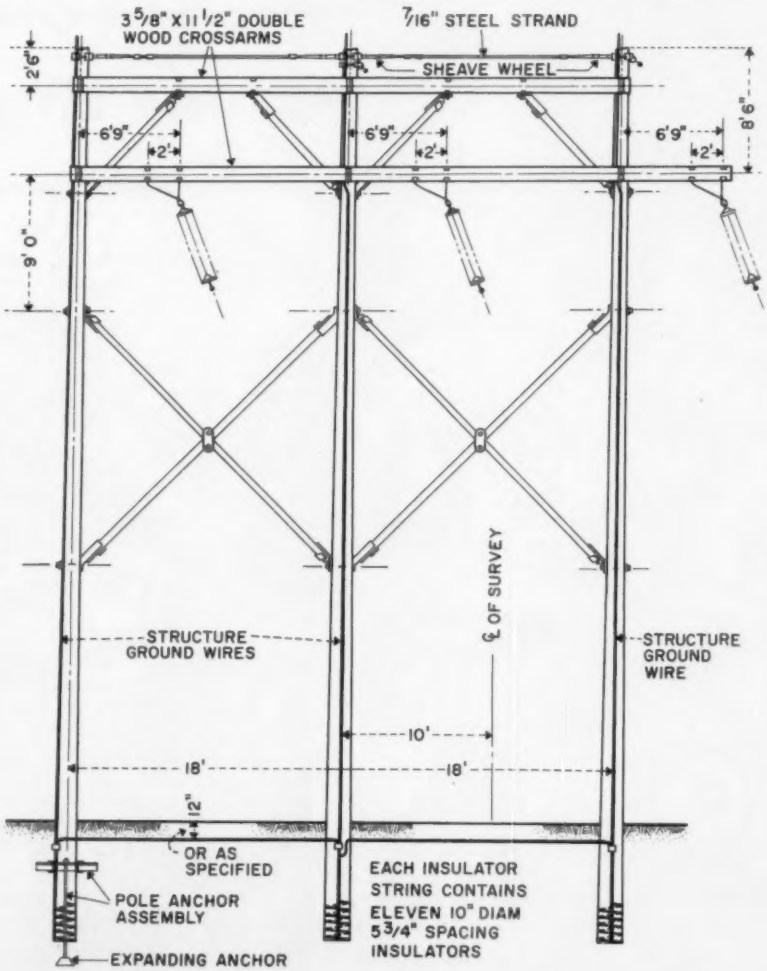
The Gustave Hirsch Organization, Inc., Columbus, Ohio, began adding to Sioux City substation in April, and will furnish and install the two steel towers leading from the substation.

The six antenna towers and buildings are being built by the Tower Construction Co. of Sioux City under a contract price of $57,077.55.

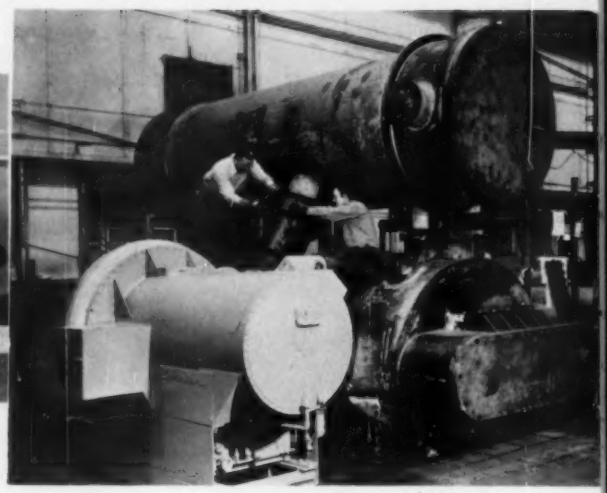
Equipment for the radio system is being supplied under a $29,155 contract to Communications Co. of Coral Gables, Florida.

Construction of the lines and substations is under direction of Bureau of Reclamation Construction Engineer R. P. Blackwell at Huron, South Dakota. The project work is in the Bureau's Region 6; Bruce Johnson, whose office is at Billings, Montana, is regional director. Grant Bloodgood is assistant commissioner and chief engineer of the Bureau; his offices are at Denver, Colorado. L. G. Puls, at Denver, is chief designing engineer. END

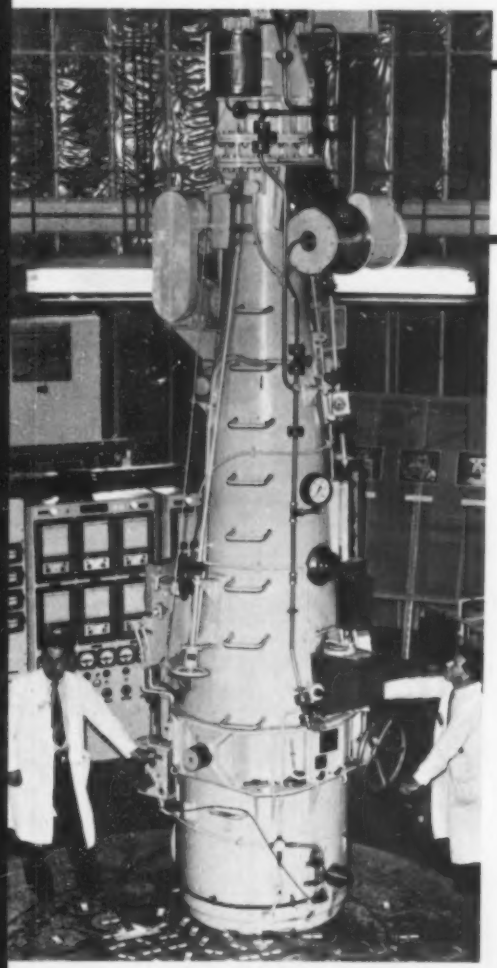
Fig. 3. Three-pole structure takes side angles up to four degrees without down guys. Note pole anchor at left which eliminates guys



One million gpd water conversion plant is now being built by Westinghouse at Point Loma, Calif., for the U.S. Office of Saline Water. It will use flash evaporation



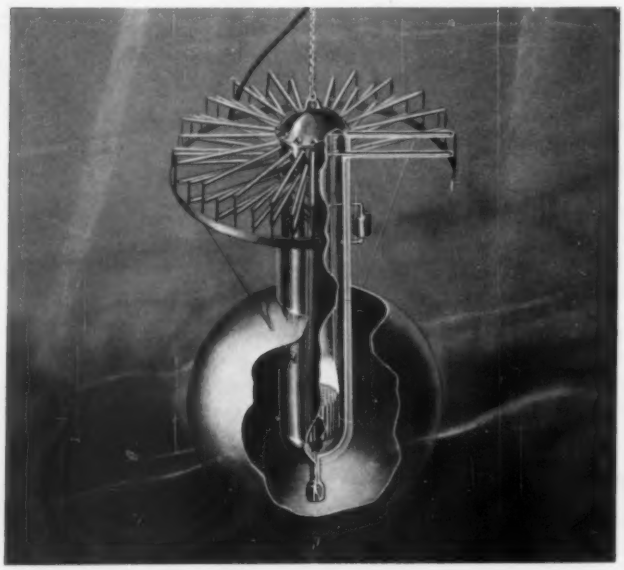
Largest hermetic centrifugal refrigerating machine, made by Carrier as one of three for Chicago's O'Hare International Airport, weighs 300 tons, can chill 4000 gpm for air conditioning

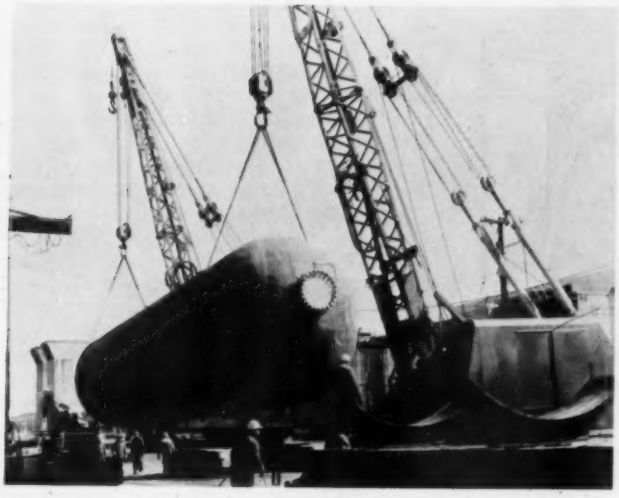


Power Engineering's

This fuel element container is used at Britain's Atomic Energy Establishment for extracting "hot" materials from research reactor

Undersea atomic power plant is visualized in this design by General Dynamics. It would operate unattended. Thermoelectric elements are in cooling tubes at the top of the shell





Job was to hoist seven 140-ton steam accumulators. Coyle & MacDonald Co. does it by pairing 80-ton cranes in highly specialized tactic demanding great precision

NEWS REEL

Traveling at velocities up to 3400 mph, drops of water can penetrate thin pieces of metal. So Westinghouse researchers are discovering in studies on action of water on spinning turbine blades. This photo shows how drop of water, shot as a jet from compressed air "gun", penetrates aluminum and puts sizable dent in steel. Peculiar light (photo above) is emitted when water strikes metal. Exactly where the light comes from has not yet been fully explained

ECONOMIC PRIMER ON CAPACITORS

General Electric Capacitor Dept.'s John A. Sainz reviews how capacitors improve system economics

ENERGY UTILIZATION DEVICES such as motors, welders, induction-heating equipment, etc. have changed the nature of the growing electric load because of their magnetizing energy requirements. Consumers are billed for kwh which are converted to useful work. Magnetizing energy (kvar-hrs) is not used up or converted to other forms of energy. Instead, it is merely interchanged between load devices and energy source.

The transmission and distribution system also requires magnetizing energy, which may be considered as an additional kvar-hr load. This reactive requirement increases in more than direct proportion to the consumer magnetizing loads which the system carries.

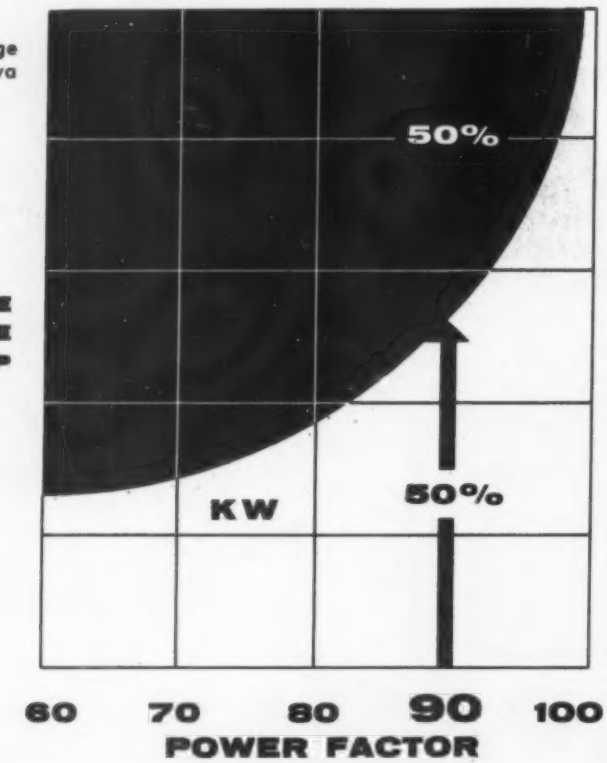


Fig. 1. It costs voltage to transmit reactive kva

MAGNETIZING LOAD SUPPLY. A shunt capacitor cannot generate energy, but it can alternately store and discharge it, and thus can serve as a source of magnetizing energy. The magnetizing kvar-hrs can be transferred back and forth between the capacitors and the magnetic load devices. Because of this, it is not necessary to obtain all load magnetizing requirements from remote generating stations.

The capacitor, or generator, to supply magnetizing energy is measured by the kvar rating. The installed cost per kvar for the capacitor is comparable to the added investment required for kvar capability in a generator.

Cost per kvar for capacitor banks does not vary appreciably with bank size. Since magnetizing load can be economically furnished from many comparatively small capacitor banks scattered throughout the load areas, there is no economic justification for the additional investment otherwise required for the transmission of kvars from remote generating stations.

CAPACITOR ECONOMICS can be evaluated in terms of system voltage drop, system losses and system ther-

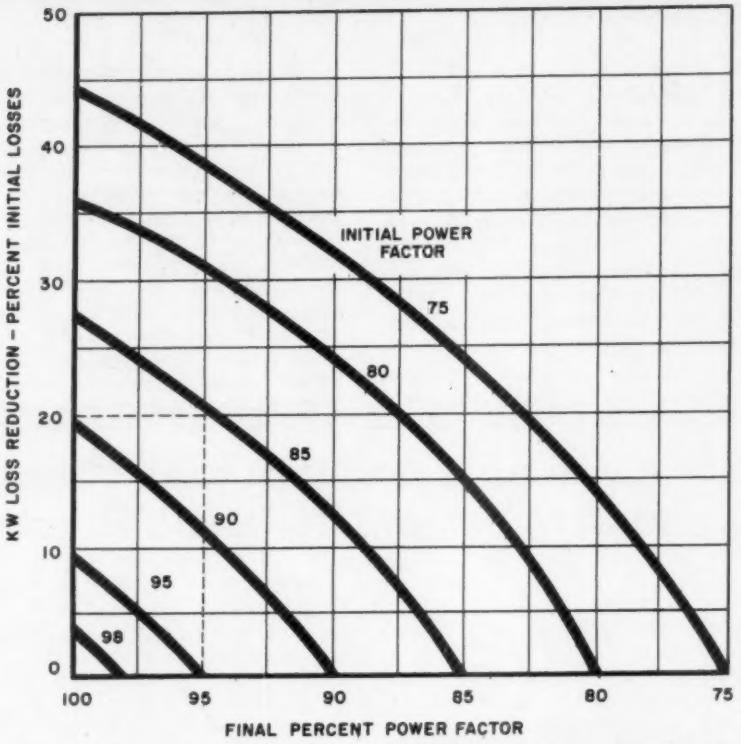


Fig. 2. Save with better power factor

mal loading. All affect system operation and investment.

The consumer measures the quality of service he receives by the voltage level. The transmission and distribution system introduces a considerable voltage drop between generator and load. In general, magnetizing energy transmitted through the system causes at least half of the total system voltage drop, as shown in Fig. 1.

Supply kvar from the generator, therefore, results in additional investment in voltage-regulating equipment to maintain satisfactory consumer voltage levels. But, even more important, it limits the amount of kwh revenue load which the system can deliver within the acceptable voltage standards. Local kvar supply with capacitors will permit the same transmission and distribution facilities to deliver more pay load.

For example, engineering studies have concluded that the installation of one capacitor kvar on the primary distribution feeder will enable the existing power system to handle an additional kw of load, while maintaining the same voltage level.

The alternative to this $4 to $6 per kvar installed capacitor cost is an expenditure of $30 per kw, or more, for additional lines and voltage regulating equipment. This relationship between system loading and system voltage drop is such that it is often desirable to furnish some of the system reactive requirements from capacitors located in the load areas. That is, to obtain heavy circuit loading economically, distribution peak load power factor in the leading range may be justifiable.

The lower investment in capacitors also results in better voltage levels. Capacitors reduce the voltage drop of the entire system by eliminating one important cause of system voltage drop. Other voltage-regulating equipment and fixed boosts merely compensate for voltage drop by raising the voltage level but do not reduce the actual voltage gradient through the system. With capacitors, the flatter voltage profiles through the system and on the distribution feeders generally result in more revenue.

SYSTEM LOSSES. Electric energy transmission (both kw and kvar) through the high-voltage system is accompanied by losses due to heat dissipation in lines and equipment.

Evaluation of losses includes kw machine capability plus fuel involved in generating energy losses, and also includes the transmission facilities needed to deliver the energy to the point where the losses are incurred. At the time of system peak loading, generator capability may be worth $150 or more per kw, while transmission facilities may add another $100 per kw. Energy charge may range from 2 to 5 mils per kwh. On an incremental peak loss reduction basis, it is generally not economical to transmit more than 10 to 15 kvar per 100 kw during the peak load period. This corresponds to approximately 99 per cent power factor.

The consideration of fuel charge alone may justify reducing kvar transmission to less than 35 to 45 kvar per 100 kw, or a range of about 92 to 94 per cent power factor. Many utilities plan their capacitor program on the basis of system loss reduction, recognizing voltage improvement as an extra benefit. Fig. 2 can be used to quickly obtain the loss reduction resulting from power factor correction. The dashed lines illustrate that a 20 per cent kw loss reduction can be obtained by correcting from 85 per cent to 95 per cent power factor.

THERMALLY LIMITED EQUIPMENT. The third aspect of capacitor economics can be evaluated in terms of efficient use of thermally-limited equipment, such as transformers, regulators, switchgear and cables. These devices have a maximum ampere capability. It is desirable to utilize this capability with kw loading which results in revenue. Magnetizing power, or kvar, reduces the efficiency by requiring a larger investment and more physical equipment to serve a given kw load. Power factor, of course, is a measure of this efficiency.

Thermal equipment carrying 50 kvar per 100 kw is handling electric energy at 90 per cent power factor. That is, only 90 per cent of the thermal loading is being used to carry pay load. The installation of capacitors to reduce this to 10 kvar per 100 kw would result in better than 99 per cent efficiency. Again, with transmission and distribution facilities evaluated at $100 per kva, the low cost of kvar from capacitors does not warrant transporting more than 10 to 15 kvar per 100 kw from the remote generating stations.

No matter which of the foregoing factors is used to evaluate the alternative means of kvar supply, the economic solution in terms of system investment and quality of service will be to furnish magnetizing energy from shunt capacitors in the distribution load area. END

CLOSED-CHEST HEART MASSAGE

is a valuable addition to first-aid, as explained by John J. Misic, of Cleveland Electric Illuminating Co.

CLOSED-CHEST HEART MASSAGE is not really "new." There were writings about it as far back as 1880. The really new aspect is that it is now being taught for general use. It gives the layman another means which he can use to try to save a life.

In the past, many failures to resuscitate by concentrating on the breathing only have probably been due to the fact that the heart was in trouble also. Closed-chest heart massage is a fast and safe technique for saving life when the heart stops or is in ventricular fibrillation because of an accident or other causes.

In practicing artificial respiration, we have progressed from the prone pressure technique, through the hip roll or arm lift method, to our present mouth-to-mouth or direct-breathing procedure. Recently on the recommendation of Dr. H. B. Wright, our medical director, we added the closed-chest heart massage technique to our first-aid resuscitation training. However, at the Cleveland Electric Illuminating Co. we look on this type of training as our second line of defense. The primary effort must be directed toward the prevention of accidents.

Following are the key instructions that are included in our first-aid resuscitation technique pamphlet.

IN ACCIDENT SITUATIONS, three things may have happened: 1. breathing has stopped but the heart is beating; 2. breathing and heart have both stopped: 3. breathing has stopped and the heart is in ventricular fibrillation.

The one thing needed in all cases is oxygenated blood delivered to the brain and body. Speed in starting resuscitation is absolutely essential because brain damage may occur within minutes. If the heart is beating, all that is needed is to provide oxygen by artificial respiration.

If the heart is *not* beating or is in fibrillation (no pulse will be found in either condition) then two things must be done: give artificial respiration to supply oxygen, and closed-chest heart massage to pump the oxygenated blood to the brain and body.

If the heart stops pumping due to either standstill or ventricular fibrillation because of injury or other causes, starting closed-chest heart massage at once can save a life. In fibrillation the normal rhythmic action of the heart is replaced by irregular, disorganized twitching of the heart muscle fibres. In this condition the heart does not pump blood. Since in these cases normal breathing also stops, direct-breathing artificial respiration must also be given to provide the oxygen necessary to save the life.

Artificial respiration is also necessary, of course, in those cases where only the breathing has stopped and the heart is beating normally following an accident—for example, in drowning, gas poisoning, or in many cases of electric shock.

Time is vital in all these cases. Resuscitation must be started *at once* and be continued until the patient revives or until medical people have taken over. All such patients should be taken to a hospital as soon as possible, even when they appear to have revived completely.

HEART MASSAGE TECHNIQUE. As a result of research by Dr. W. B. Kouwenhoven and others, a fast and safe technique is recommended for reviving a heart that has stopped. It can be used in any accident situation in which the heart has stopped or is fibrillating. Be sure the heart is in trouble. You can do this by checking for pulse in the wrist or neck. But do not waste time in making a decision. No complex equipment is required, only the hands.

The heart lies between the breastbone and the spine. Pressure on the breastbone compresses the heart, forcing out blood. Removing the pressure allows the heart to refill (Fig. 1). In an unconscious person the compression of the chest cage by pressing on the breastbone is surprisingly easy.

With the patient lying on his back, preferably on a rigid surface, the heel of one hand with the other hand on top of it, is placed on the lower third of the breastbone (Fig. 2). The landmarks for locating the breastbone are the flexible cartilage at its lower end, and the notch at its upper end. The heel of the lower hand rests on the breastbone just above the cartilage.

Firm pressure is then applied vertically downward about 60 to 80 times a minute. At the end of each pressure stroke the hands are lifted slightly to permit full expansion of the chest. The operator should be in a position which will enable him to use some of his body weight in applying the pressure.

The chest will be somewhat rigid at first but in a few strokes it will be possible to press the breastbone downward 1½ inches or more. Pressure should be with the heel of the

lower hand only. No pressure should be applied with the fingers.

When the pressure has been started immediately after heart stoppage, people have been resuscitated, without brain damage, after the heart massage and artificial respiration have been continued for as long as one hour.

OVER-ALL SAFETY. We should always consider any form of resuscitation training as only one part of our total safety effort.

This over-all safety program has been encouraging. The accident rate for our industry has decreased and is under the all-industry average. Millions of accident-free man-hours have been worked by power companies, as evidenced by the EEI safety achievement awards made each year. This is ample proof that we have the know-how and that the accident-prevention job can be done. I believe that we must review these facts and be aware of them, for in this way we gain much encouragement to carry out our responsibilities for accident prevention.

TO SUMMARIZE, I would like to review some of the points that must be emphasized in our first-aid program:

1. Accident prevention must always be the primary safety activity, with training in resuscitation and other first-aid techniques as a second line of defense.

2. Heart massage now provides an easy means for the layman to help a heart that is not functioning.

3. When a heart is stopped or in fibrillation, two things must be done: give artificial respiration to provide oxygen and give closed-chest heart massage to pump oxygenated blood to the brain and body.

4. Remember: Time is vital in all these cases. Resuscitation must be started at once and continued until revival or until medical people have taken over. All such patients should be taken to a hospital as soon as possible, even when they appear to have revived completely.

5. While a stopped heart may recover normal beating when circulation has been maintained, the fibrillating heart case must have treatment at the hospital. Heart massage makes it possible for the fibrillating heart case to reach the hospital with a good chance for survival. END

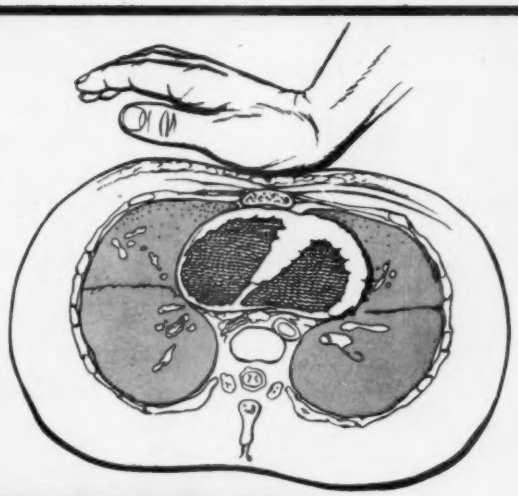
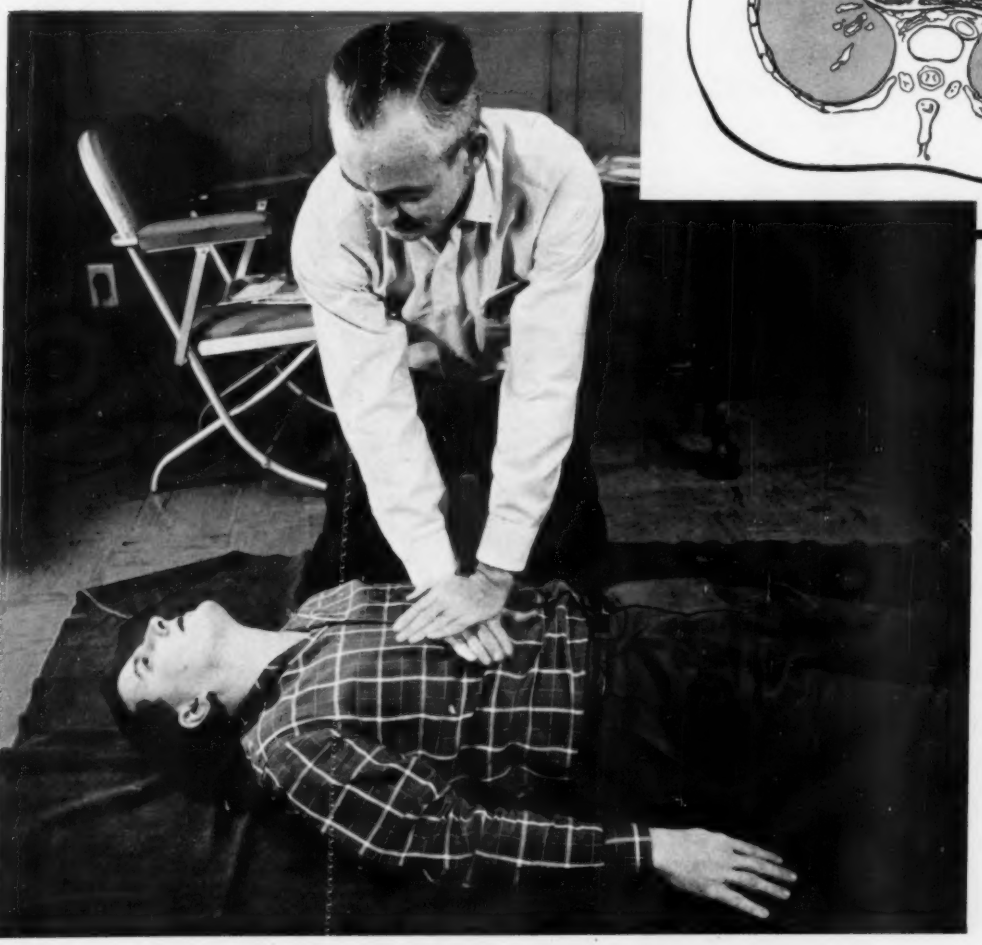


Fig. 1. Pressure on breastbone compresses heart. Fig. 2 (below) Heel of lower hand rests on the breastbone



UTILITY RADIO GIVES "ACROSS THE BAND" BENEFITS

Radio continues to extend the arms of power engineers and system operators

RADIO IS HELPING to keep operating efficiency at peak highs while making the most of every utility communications dollar spent.

Microwave radio relay systems not only give protective relaying, but provide telephone communications between offices and stations, transmit telemetering and teletypewriter information, control VHF radio, and many other benefits.

Mobile two-way radio "puts the office in the field." Special tone signaling equipment permits maximum use of channels and allows dispatchers to contact men individually as well as alert them of messages when they are working away from their vehicles.

Protective relaying on HV transmission line systems by microwave radio is being used by leading utilities throughout the nation because of inherent benefits of reliability, high speed and high capacity. One of these utilities is Potomac Electric Power Co. of Washington, D.C.

Specifications for protection of a new 230-kv line consisted of: relaying speed of three or less cycles; maximum reliability in keeping with the critical role of the line; and a means of intercommunicating between the system's terminals.

Microwave radio was chosen after careful study of its capabilities and those of power line carrier and leased wire lines. Its capability of handling full relay circuit requirements plus telemetering, supervisory control and voice was found to make it just as or more economical than either leased lines or carrier.

The line (see Fig. 1) extends from a new generating plant at Dickerson, Maryland, for about 20 miles to Bell's Mill Road substation, where it joins the remainder of the system. Midway, at Quince Orchard junction, a second portion of the 230-kv line begins a circular route to the Burtonsville substation, which is the interchange point for the Washington-Baltimore network. The line continues back towards the District of Columbia to the Takoma substation.

PROTECTIVE RELAYING requirements are for three terminal circuits between Dickerson, Bell's Mill Road

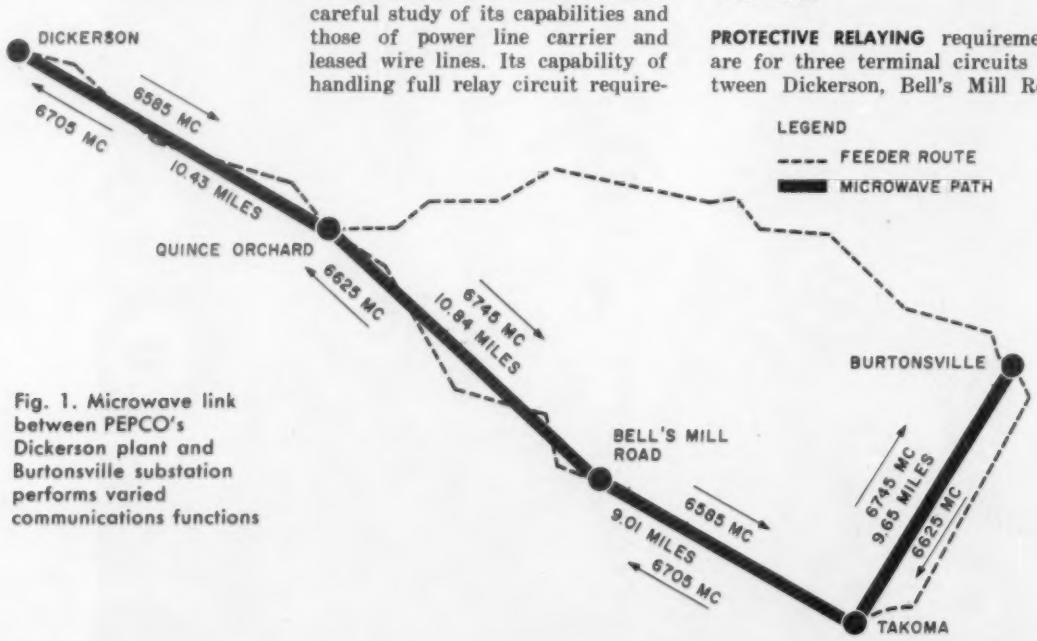


Fig. 1. Microwave link between PEPCO's Dickerson plant and Burtonsville substation performs varied communications functions

(See Fig. 3) and Burtonsville. Other circuits are needed for the Burtonsville - Takoma transmission lines.

Propagation surveys indicated the most economical method of connecting the four terminals was to be the Dickerson-Bell's Mill Road-Takoma-Burtonsville route. A high ridge near Dickerson necessitated use of a repeater station midway to Bell's Mill Road. The station is located at Quince Orchard. While serving as a repeater now, it will one day become a terminal station as the Quince Orchard gear is expanded into a switching station. Total microwave system distance is about 40 miles. The four hops range from slightly more than nine to almost 11 miles each.

Primary function of the microwave system is to provide adequate numbers of highly reliable and fast circuits for protective relaying purposes. There are 28 relaying channels between Dickerson, Bell's Mill Road, and Burtonsville for protection of two three-terminal 230-kv lines.

An additional 18 relaying channels link Burtonsville and Takoma for the two 230-kv circuits between those points.

PEPCO has 46 relaying circuits, using only 30 of the 40 available subcarrier frequencies. The remaining channels are adequate for all future needs.

Total tripping time is about 5.5 cycles. Circuit interruption requires three cycles. Fault detection and communication to breakers takes about 2.5 cycles.

OTHER MICROWAVE uses include communication of voice, telemetering and control data. Seven voice multiplex channels are in use. Three serve as duplex telephone circuits between Dickerson and Takoma. Many more channels are available.

Telemetering and control information channels accomplish: 1) remote supervision and control of the Bell's Mill Road and the Burtonsville substations from Takoma; 2) telemetering of the interchange information from Burtonsville to Takoma; and 3) telemetering Dickerson power generation information to Takoma and interchange information back to Dickerson. Several of the telemetering and voice channels

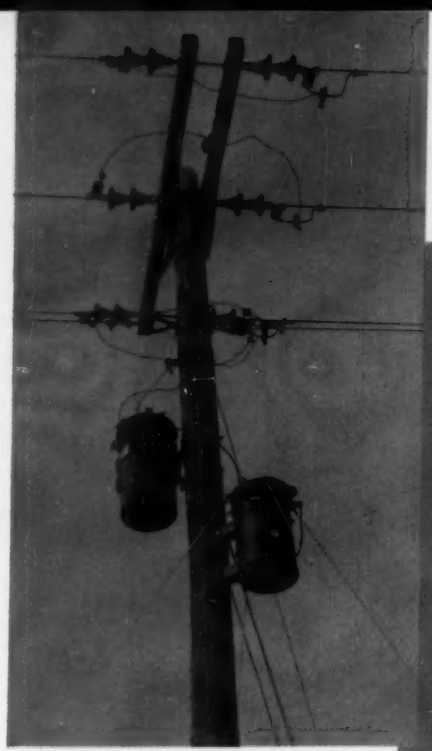


Fig. 2. Transmitter in weatherproof tank monitors operations of remote equipment

are carried on from Takoma over leased lines to the Power Dispatcher's office in PEPCO'S main office in downtown Washington.

Four major microwave components by Motorola handle the system: microwave carrier—MR-20 RF equipment; protective relaying multiplexing — MC-22 equipment (all transistorized); voice circuits — MC-20 multiplex terminals; and submultiplexing telemetering and supervisory control information — Voice Frequency Carrier (VFC) equipment. (See Figs. 4 and 5.)

As many as 600 subcarrier channels of toll quality voice communications are provided through use of single-sideband multiplex equipment. Single-sideband suppressed-carrier operation permits an extensive list of signaling and terminal options—13 standard signaling options which can be obtained by merely changing plug-in etched circuit cards.

TWO-WAY RADIO keeps improving operations through specialized equipment application. Such an application, designed to make maximum use of available channels, is used by Northern Illinois Gas Co.

With mobile repeater, selective signaling, single-tone base station control and tone decoded squelch

Fig. 3. Reflector tower at Bell's Mill Road is 250-ft high. One path extends 10.84 miles to Quince Orchard, the other 9.01 miles to Takoma

Fig. 4. Technician is utilizing the service channel provided in the new transistorized microwave equipment to signal another station

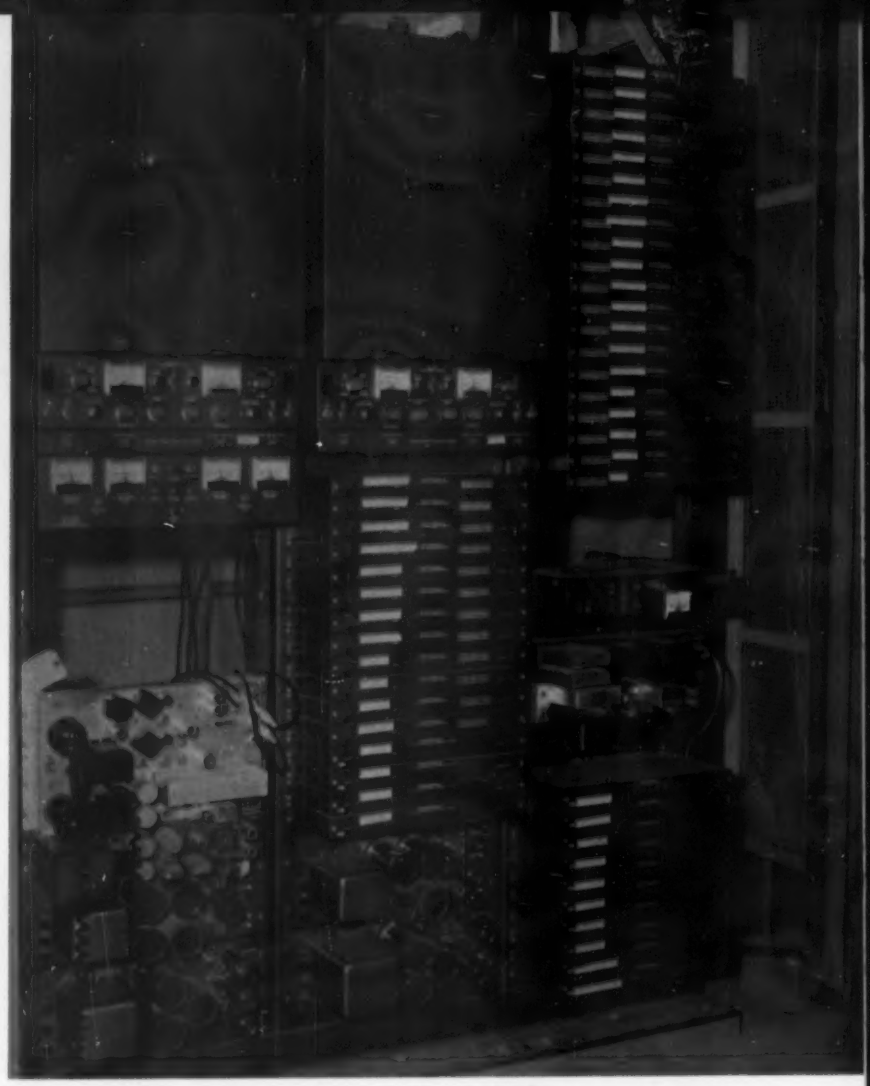


Fig. 5. Terminal station includes normal and standby MR-20 RF equipment, MC-20 multiplex equipment, MC-22 protective relaying multiplex equipment and VFC terminals

techniques, this company has established a communications network for its ten operating districts that works on three frequency bands.

The network consists basically of two systems. The 450-mc system includes four base stations transmitting on one frequency. The associated mobile units transmit on another frequency. The crossband system consists of eight base stations transmitting on one low-band frequency and associated mobile units transmitting on one high-band frequency.

Two types of base stations are used in the two systems. The major station for each district is a mobile relay station in which all messages received from mobile units are automatically retransmitted. This enables long range mobile-to-mobile communications and eases the load on the second type of base station—the operational fixed control station.

The control station technique is used in instances where the dispatch point is too far from the mobile relay station for practical use of wire line remote control. These control stations are like fixed mobiles since they transmit on the mobile "transmit" frequency to the mobile relay stations and receive on the base station "transmit" frequency from the mobile relay station.

ALL MOBILE UNITS are equipped with selective-calling decoding devices. The base station operator, equipped with a "Quik Call" signaling console, can call either an individual vehicle or the entire mobile group assigned to his station by sending out the proper tone codes. This feature eliminates the need for the mobile operator to monitor all transmissions since he hears only those meant for him.

When the selective calling decoder is connected to an auxiliary relay, the horn or an external light can be operated to alert the driver to a radio message when he is working away from the vehicle.

Transistorized two-way radio's high-reliability, low battery drain characteristics and compactness are saving money for users. With reduced rates because of reduced maintenance needs, South Jersey Gas Co., Atlantic City, New Jersey, saves about $10 per year per unit with transistorized equipment as compared to tube type units.

Low battery drain characteristics enable drivers to monitor their vehicles while parked on jobs without running the engine. This has saved the company (based on one year for each mobile unit): gasoline costs, $10; gasoline costs from eliminating one hour of vehicle idling per day, $60; engine overhaul costs resulting from idling, $5.

REMOTE OUTAGE REPORTING gives a further clue to radio's future helpfulness to utilities. Transmitters, located at strategic points on the line, monitor equipment operation and send out a distinctive tone signal to the base station and Digital Recorder in the central office, notifying the dispatcher of the occurrence and its location. (See Fig. 2.)

In most cases, the unit operates in conjunction with a recloser and is triggered if a line fault causes the recloser to lock out.

Salt River Power Project, Phoenix, Arizona, recently ordered a 16-unit system. However, a total of 290 remote alarm indicators can be included in a single system. END

300-CYCLE MOTOR DRIVES COMPACT PACKAGED CHILLER

BRIGHT NEW STAR in the American-Standard family of liquid chillers is the Packaged Tonrac. This new hermetically-sealed centrifugal refrigeration unit is reportedly only half as big and half as heavy as any conventional centrifugal unit

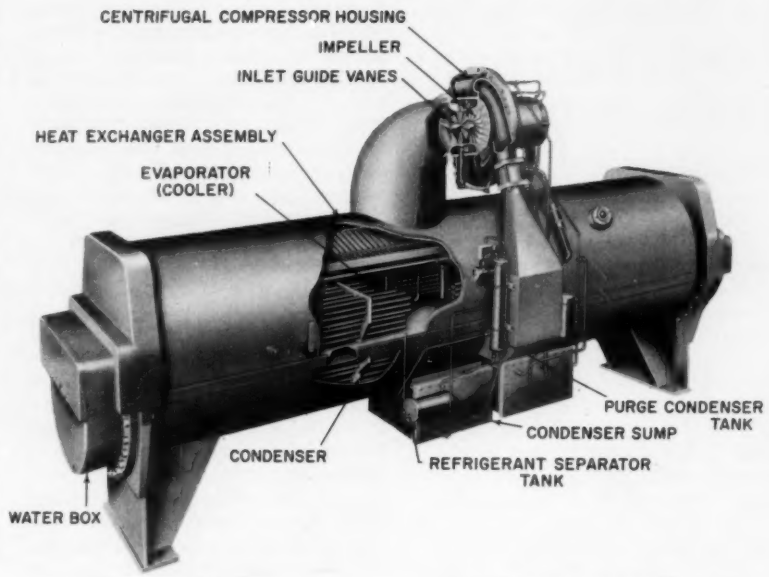
Available in eight sizes from 50 to 100-ton refrigeration capacity, the complete unit—all piped and factory insulated—is small enough to pass through a standard 36-inch commercial doorway.

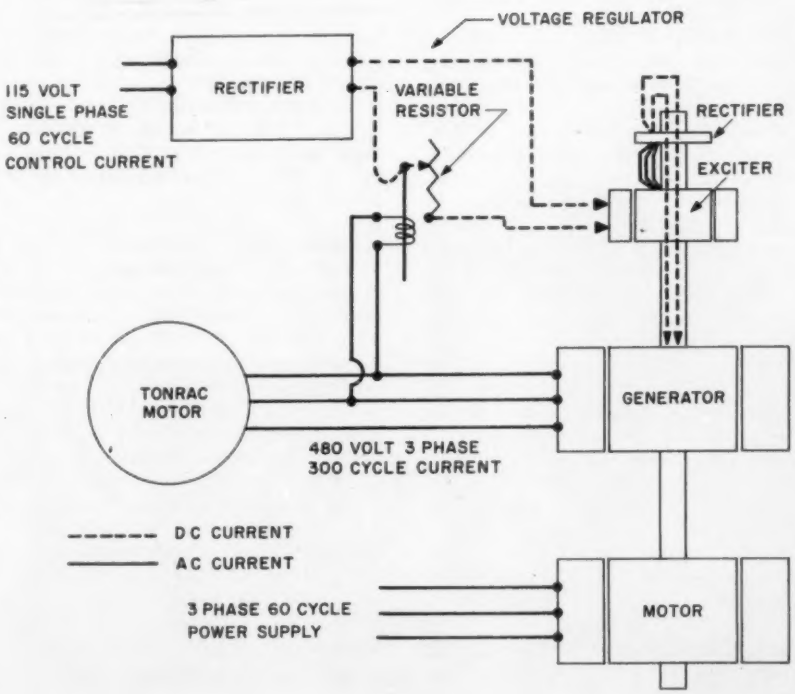
At the heart of the unique design that makes this compact package possible is a 300-cycle motor that operates at 18,000 rpm nominal speed on 480-volt, 3-phase current. Windings of the motor are cooled by refrigerant. Bearings are also cooled by the motor cooling system, so that a separate oil cooler is not necessary.

In the 100-hp size, this motor (patent applied for) weighs less than one-tenth as much as a comparable 60-cycle electric motor as commercially produced. Power is supplied from a separate motor-generator-exciter unit which converts 60-cycle line current to 300-cycle current. This unit can be located in a convenient spot, not necessarily adjacent to the refrigeration machine. The power unit generator can be driven by any rotary prime mover.

Another major accomplishment claimed for the packaged design is the integral compressorless purge system. The pressure differential which always exists between condenser and cooler is utilized to exhaust foul gases from the condenser. This eliminates the need for the separate reciprocating compressor.

Complete factory packaging means that the only water piping required on the job is that for the air-conditioning load, and that from the cooling tower to the condenser. The unit is intended for use as the heart of central-station air-conditioning systems, providing chilled water for operation of zone or individual room conditioners. END





WHY CORROSION?

In the second of three articles, Earle Sommerfield of United Engineers and Constructors explains kinds of corrosion the power engineer meets

THE MANY JOINTS normally required in all equipment and structures provide ready opportunities for concentration cells and crevice corrosion. Intensified attack can occur at local anodes in crevices on both inside[1] and outside surfaces of equipment. The designer should avoid crevices by using welded joints where practical. Contacts involving non-metallic materials such as plastics, wood or fabrics can also be dangerous. Opportunities for the collection of concentrated solutions at inaccessible points in liquid-carrying equipment must be minimized. Provide for complete drainage of tanks, avoid pockets; connecting nipples must not project into vessels and tanks.

Another manifestation of galvanic action is the graphitization of cast iron. This results from local cells being set up between the graphite flakes and the iron of the casting and can result in the complete destruction of the cast iron, when exposed to an electrolyte. Large cast iron water boxes and strainer bodies are susceptible with aggressive water.

DEZINCIFICATION is another type of galvanic corrosion which occurs in brasses containing more than 15 per cent zinc.[2] Most common occurrence of this phenomenon is in brass condenser tubes. In the presence of an electrolyte, dezincification is created by the alloy going into solution followed by a redeposit of copper in a porous form which has little mechanical strength. (Figure 2.)

The problem is largely under control by the addition of inhibitors such as arsenic, phosphorus, or antimony in small amounts.

Cooling tower hardware is subject to this attack and care should be taken to install red brass or silicon bronze, which are not subject to dezincification.

INTERGRANULAR CORROSION of sensitized austenitic stainless is a form of galvanic attack at the grain boundaries.[2] *Sensitization* is created when stainless steel of the 18 Cr 8 Ni type is subjected to temperatures between 800 and 1600 F. This produces an intergranular chromium carbide precipitate which depletes the adjacent grain boundary area of chromium. Subsequently, when such sensitized material comes in contact with certain electrolytes, an attack occurs preferentially along the grain boundaries depleted of chromium.

This phenomenon is well known in the chemical industry, and for its prevention the stabilized grades Types 321, 347 or 304L are required in critical services. Type 304 is used only in non-critical services or in furnace piping where the metal is not exposed to aqueous environments. In the latter case, care should be taken during shutdown periods that the temperature does not drop below the dew point (and in power plants which are shut down or operated at light loads, it usually does). Failures of 304 in this service by intergranular corrosion have been caused by condensed flue gases containing SO_2.

GROOVE CORROSION is a type of galvanic corrosion which preferentially attacks heat-affected areas of steel equipment when exposed to certain corrosive media.[2] When steel is heated as in welding, a narrow band of spheroidized structure is formed adjacent to the weld (the iron carbide forms into spheres).

In certain electrolytes this zone is anodic to the parent metal, and a high localized rate of attack occurs. The remedy is to normalize the parts after welding. Groove corrosion has been noted in systems handling strong sulphuric acid and strong caustic.

AIR AND OXIDIZING GASES. Any metal or alloy exposed at high temperatures or to combustion products of hydrocarbon fuels, to steam or to many other compound gases containing oxygen, may be susceptible to a corrosion process that converts the surface material to an oxide.[3] All common heat-resisting alloys not only form oxides, but do so rapidly on initial exposure to an oxidizing environment. Whether resistance to continued rapid oxidation is exhibited for longer exposures depends upon whether the oxide provides an effective barrier separating the gas and the underlying metal.

If this desirable condition results, it is theoretically possible for the corrosion process to be slowed to a very low rate. Chemical nature of the oxide is of some importance in influencing this process, but physical characteristics such as adherence, expansivity, specific volume, and elasticity are of greater practical moment. Laboratory studies show, with many alloys, the oxide may offer good protection when of limited thickness, but as the thickness increases with time, there is usually a tendency for fissuring or cracking. A break in the film exposes fresh

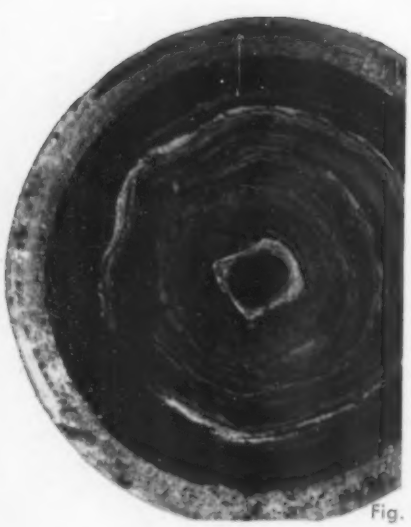


Fig. 1. Return line clogged with corrosion products, result of CO_2 and oxygen

metal and permits the corrosion to take place at the initial high rate.

Loss of fragments from the above action represents scaling in the common sense. Clearly this process is a serious matter, since it represents a loss of section and load-carrying or pressure-retaining capability. Mild steel is seldom used above 950-1000 F because of excessive scaling rates. Higher temperatures require chromium, which diffuses rapidly and accumulates at the surface, providing a tightly adherent oxide film that materially retards the oxidation process. Increase of maximum operating temperature with increase of chromium content is as follows:

Per Cent Cr	Max. Temp. F
4 — 6	1150 — 1175
9 — 12	1300 — 1400
14 — 18	1400 — 1500
27	2000

Another element useful in imparting oxidation resistance to steel (complementing the beneficial effects of chromium) is silicon. In the lower chromium ranges, silicon in amounts of 0.75—2 per cent (weight-percentage) is more effective than chromium. The well-known austenitic stainless steels containing 15—25 per cent chromium and upwards of 8 per cent nickel, in addition to their useful corrosion-resisting properties at normal temperatures, feature excellent oxidation behavior. Increase in nickel content improves resistance, especially in cases of very high temperature or cyclic heating and cooling.

HYDROGEN SULFIDE. One of the commonest forms of high-temperature destruction of metals is that resulting from environments containing sulfur.[3] In many applications involving the use of various types of fuel, the need for materials having satisfactory resistance to high temperatures dominates all other factors considered in the selection of alloys. Generally speaking, resistance to sulfidation directs the choice of alloy composition, compromising properties of strength, fabricability, or resistance to other types of destructive elements.

In many respects, sulfidation resembles oxidation. Sulfidic scales form which, under some conditions, may provide a protective barrier. But the physical and chemical characteristics are a good deal more sensitive to the temperature of formation, concentration of the corrodent, and especially with respect to the form in which sulfur exists in the environment.

The type of attack may be considerably dependent upon whether the sulfur is in elemental form, or as H_2S or SO_2, in the oxidizing combustion products of a sulfur-containing fuel. Nature and extent of attack in each case may be quite different, as well as the type of alloy composition used in combating the particular type of attack.

One of the main differences between oxidation and sulfidation is that sulfidic scales more often show poor adherence characteristics which leads to exfoliation and the creation of problems of metal wastage or fouling of other equipment by scale debris. Another difference is the common trait of sulfide phases having comparatively low melting temperatures and, in addition, forming even lower melting mixtures with most constructional metals.

Chromium is the most valuable element in imparting resistance to steel against most forms of sulfur attack. Similarly, silicon and aluminum, among minor alloying elements, afford some protection, although with aluminum the high percentage required is more easily secured by *surface enrichment*.

Pure nickel reacts avidly with sulfur in practically any form to produce low-melting sulfur eutectics situated in grain boundaries and, therefore, potent in embrittling effect. (Eutectic is an alloy with the lowest melting point attainable.) This tendency is still evident in the intermediate nickel containing chromium steels and works against their selection for handling large sulfur concentrations, especially as H_2S, and at higher temperatures.

VANADIUM PENTOXIDE is the one which causes most of the trouble when firing Venezuelan oil. The attack is usually severe on superheater and reheater tube supports, spacers and baffles operating at high temperatures.

Such metal destruction is caused by the fly ash[5] or residues from combustion products of the oil which, having a relatively low fusion range, can destroy the metal's normally protective oxide. Ash constituents contributing to the attack are mainly vanadium, which originally exists in the oil as an asphaltic compound; sulfur, also present in organic form; and salt from underground brine or from sea water trans-shipments.

In the deposited ash, these elements form compounds usually identified as V_2O_5 and Na_2SO_4, which in mixtures of certain proportions, can have fusion temperatures as low as 1145 F. Results of studies to discover better materials have been uniformly discouraging. Employment of additives to the fuel such as oxides or sulfates of calcium, magnesium, aluminum, etc., are considered to be helpful, but have not been satisfactory in all cases.

Diamond Power Specialty have developed a method of feeding a slurry through the soot blowers. The slurry deposit raises the fusion temperature of the oil ash deposit on the superheater and reheater tubes. The slurry is a mixture of water and commercial lime with a high magnesium oxide content. Use of pressure tubing for tube supports through which the steam passes should prove helpful in this problem, in that the temperature of the support is thereby reduced.

RETURN LINE CORROSION. Condensate system corrosion results from the action of two gases dissolved in the condensate—carbon dioxide and oxygen.[4,5] Carbon dioxide is found in boiler feedwater in two forms, either as free CO_2 or "bound" in the form of carbonates and bicarbonates. These compounds break down in the boiler, releasing CO_2 which passes out of the boiler with the steam. It then dissolves in the condensate, making it acid and highly corrosive,

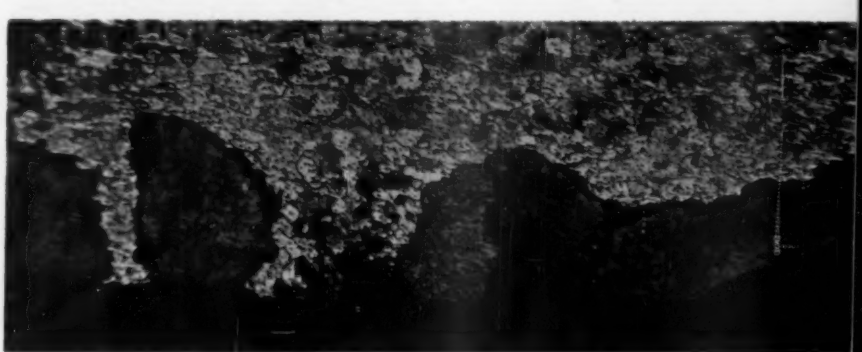


Fig. 2. Dezincification most commonly occurs in brass condenser tubes. Dark areas are loss of zinc
Armour Research Foundation

resulting in grooving of the bottom of the pipe.

Dissolved oxygen may be present in the boiler feedwater or may result from inleakage of air into the condensate system. Its presence accentuates the corrosion problems, frequently causing rapid localized pitting attack and build-up of iron oxide deposits. Since the solubility of dissolved oxygen decreases with increasing temperature, the use of an open or deaerating heater is of importance in satisfactory design of a boiler plant.

To assure that the last traces of dissolved oxygen are removed, ordinarily the feeding of sodium sulphite is indicated. In high-pressure installations, where concentration of dissolved solids is critical, hydrazine is applied to achieve oxygen removal. Unlike sodium sulphite, hydrazine does not increase the solids of the boiler water.

Since CO_2 may be present in the condensate regardless of deaeration and since trouble may result with concentrations as low as 6 ppm, some provision may have to be made for its removal, neutralization, or protection of the piping. External treatment of the feedwater to remove a large portion of the CO_2 may be accomplished by lime-soda and lime gypsum softening, which ordinarily reduces the alkalinity to the 50-60 ppm range. Other external methods for reducing bicarbonate alkalinity to a very low level include acid feed, hydrogen zeolite softening, and dealkalization.

When external softening cannot produce a sufficiently low carbon dioxide concentration of the steam, or when the expense of such external treating facilities is not warranted, protection from attack can be achieved by the use of neutralizing amines or filming amines. Neutralization can be accomplished by certain volatile amines, which, when fed to a boiler, volatize with the steam and neutralize the acidity of the CO_2.

Where large amounts of CO_2 are present, costs can become excessive. The filming amines are then indicated, which function by laying a non-wettable film of monomolecular thickness over the metal surfaces, which is impervious to water, thereby protecting the metal. The quantity required is independent of the CO_2 concentration, and is therefore the more economical treatment where high concentration of the gas is present. The filming amines are also effective against oxygen when it is present in moderate amounts.

IMPORTANT COMMERCIAL ALLOYS[3] FOR HIGH-TEMPERATURE SERVICE

	Nominal Composition			
Ferritic Steels	**Cr**	**Ni**	**Fe**	**Other**
Carbon steel	—	—	bal.	—
2¼ chrome	2¼	—	bal.	Mo
Type: 502	5	—	bal.	Mo
410	12	—	bal.	—
430	16	—	bal.	—
446	27	—	bal.	—
Austenitic Steels				
Type: 304	18	8	bal.	—
321	18	10	bal.	Ti
347	18	11	bal.	Cb
316	18	12	bal.	Mo
309	24	12	bal.	—
310	25	20	bal.	—
330	15	35	bal.	—
Nickel-Base Alloys				
Nickel	—	bal.	—	
Incoloy	21	32	bal.	
Hastelloy B	—	bal.	6	Mo
Hastelloy C	16	bal.	6	W, Mo
60/15	15	bal.	25	
Inconel	15	bal.	7	
80/20	20	bal.	—	
Hastelloy X	22	bal.	19	Co, Mo
Multimet	21	20	bal.	Co
Cast Irons				
Ductile iron	—	—	bal.	C, Si, Mg
Ni-Resist, D-2	2	20	bal.	Si, C
Ni-Resist, D-4	5	30	bal.	Si, C
Cast Stainless (ACI Types)				
HC	28	4	bal.	
HF	21	11	bal.	
HH	26	12	bal.	
HK	26	20	bal.	
HT	15	35	bal.	
HW	12	bal.	28	
Super Alloys				
Inconel X	15	bal.	7	Ti, Al, Cb
A 286	15	25	bal.	Mo, Ti
Stellite 25	20	10	Co-base	W

MICROBIOLOGY deals with growing plants and animals. Their behavior is not like the well-defined behavior of calcium carbonate. The three main groups of organisms which may give trouble in *recirculating* cooling-water systems are algae, bacteria, and fungi.[6]

Algae are usually the least troublesome of the three groups. Algae can be subdivided into three types: blue-green, green, and diatoms. The blue-green and green algae are primarily troublesome in restricting the flow of water (and air in some cases) in a cooling tower. They flourish only in portions of the system exposed to light and air. Diatoms are composed largely of silica. These organisms are found in natural water supplies and may form deposits in piping, filters or similar equipment.

Bacteria can be subdivided into four groups: slime-forming, corrosive, iron-depositing and non-troublesome. The slime-forming, as the name implies, are responsible for a great deal of the slime found in the piping and exchangers of a cooling system. Of the corrosive type, the main offender is the sulfate-reducing bacteria by the name of *sporovibrio desulfricans*. These reduce the sulfate in the water to sulfide. The sulfide ion is extremely corrosive.

The iron depositing types are responsible for deposits of hydrous iron oxide in the cooling system piping. They take in "solution iron" and give off insoluble iron in the form of a slimy sheath around their cells.

Fungi may be subdivided into two categories, known as molds and yeasts. Both are troublesome deposits. A single mold is extremely large and extremely resistant to killing with normal chemical treatment. The relation of size of a single mold organism to that of a single bacteria organism is that of six-foot fishing pole to a cigarette; also, mold is not straight and tangles easily with other organisms. Both molds and yeasts may result from air-borne contamination of the cooling water.

Several samples of the slime or deposit should be taken from different locations, as well as from the water source, and submitted for microbiological analysis. Then consult with a water specialist. END

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WE TRY A COMPUTER FOR MONITORING AND RESULTS

N. F. Pinkstaff, station engineer, reports on venture at new Gordon Evans steam electric plant

NO. 1 UNIT of Kansas Gas and Electric Co.'s Gordon Evans Station near Colwich, Kansas, is an 1800-1000/1000 Westinghouse reheat unit with a capability of 160,000 kw. It is supplied with steam from a 1,020,000 lb/hr Riley Stoker Corp. steam generator.

The indicated advantage of using a computer in a generating station encouraged us to undertake a study to determine the economic justification of a monitoring and results computer which would take the place of the normal recorders and provide the additional monitoring desired for this station. Savings in labor and improved efficiency were taken into consideration with the added benefits of the performance calculations with immediate available results.

Results of the study indicated that due to the higher initial investment costs, no savings would result on the first unit, but with the installation of the second generating unit, savings were indicated which would increase as additional units were installed at the plant. So we purchased a Daystrom Systems solid state, random access, 4096-word magnetic core memory, digital computer system. Before describing this system in detail, a summary of our experience with it to date is in order.

TRIAL OPERATION of the No. 1 unit at Gordon Evans Station was realized on May 6, 1961. At this time the computer was receiving only a portion of the total inputs. However, from the very start, the data from the computer was utilized both by the plant operating personnel and the manufacturer's representatives for monitoring various plant measurements and obtaining operating data.

The digitalized output has been helpful in eliminating the errors usually associated with the reading of unfamiliar charts of varying scales. Also, this equipment permitted the monitoring of operating conditions in the presence of the BTG board and plant operating personnel, which made possible direct communication and observation of the effect of changes in operation.

The computer has not been fully programmed, hence at this writing it is performing monitoring, alarming and logging only. However, these features have pointed out potential troublesome areas which we expect to be verified by the results of the acceptance tests and corrective measures instituted.

The computer proper has operated satisfactorily without suffering any serious component failures since the initial "debugging," and the periphery equipment such as the logging typewriters, etc., has required only minor maintenance.

HOUSING for the computer proper is a nine-door cabinet (Fig. 1) with over-all dimensions of 85 in. high, 176¼ in. long, by 36½ in. wide. This contains the memory, logic circuits, emitters, gates, amplifiers, etc., plus the terminal connections for the various inputs and outputs with the multiplexing circuits, and plus the power supply and standby battery.

Also provided is a 40 in. wide by 76 in. long desk with a 22 in.-wide shelf upon which are two Frieden Flexiwriter logging typewriters, one Frieden Flexiwriter computer input typewriter, programming keyboard and program checking lights, and a

This article is based on a paper given at a conference of the Missouri Valley Electric Association.

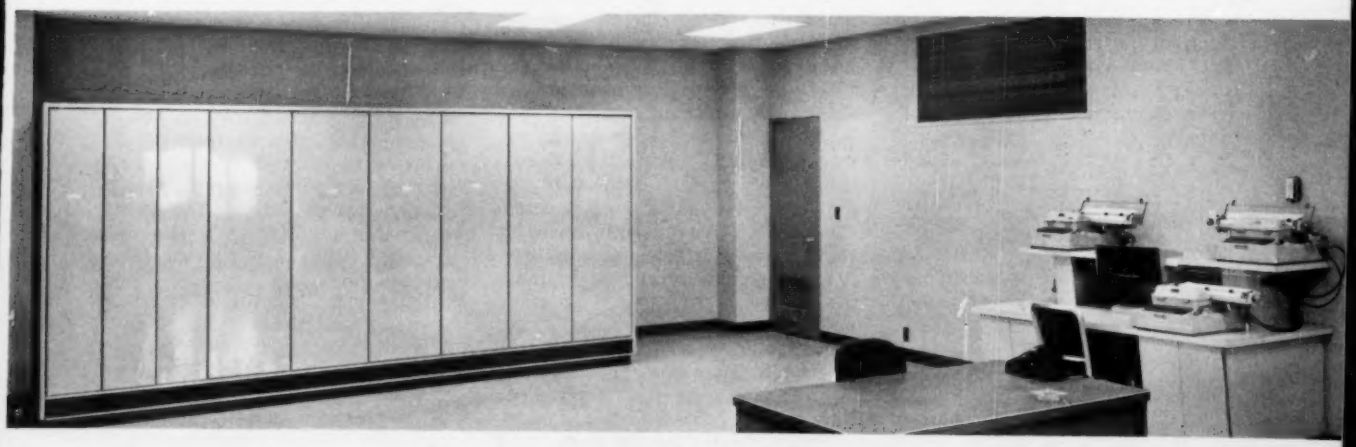


Fig. 1. Nine-door cabinet houses computer. On desk are logging and input typewriters, other equipment

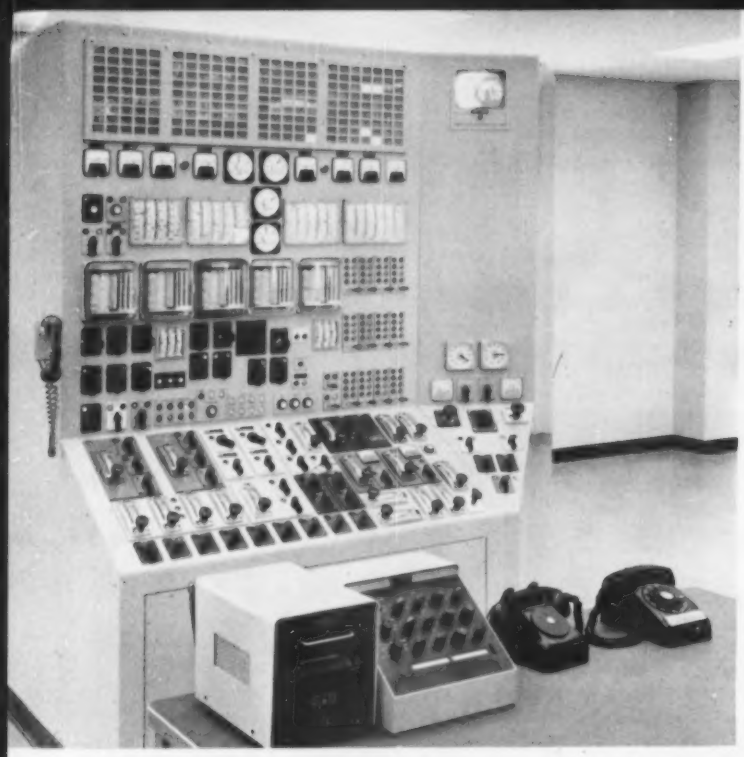


Fig. 2. On desk in front of BTG board are computer function switches which control readout devices. Also alarm

Ferranti tape reader and spooler. Located on the plant control operator's desk is a demand switch console and a Hewlett Packard digital recorder which is used as an alarm printer.

The computer's basic components consist of 90,112 magnetic cores or memory cells arrayed in 22 planes, 64 by 64 each, 4386 transistors, 13,437 zener diodes, 12,949 resistors, 1455 capacitors, 521 mercury-wetted relays for external switching, and approximately 15.5 miles of electrical wire.

This equipment is for only one-fourth of the total 16,384 maximum possible word memory available with this computer, and it consists of 4096-word memory with each word consisting of 20 binary bits plus a sign and a parity check. Also, with minor adaptation the computer can be altered to handle 32 logging typewriters plus a magnetic tape unit.

The computer performs all calculations in binary with programming and programming readout being in even octal. Computer speed originates with a 200-kc crystal which is divided twice so that the basic computer speed is 50 kc, which permits a bit time of 20 microseconds; or, to handle the 20 bit word plus sign and parity requires 440 microseconds, as most operations and internal bit transfer are done serially with only a few specific operations being performed by parallel transfer.

The computer will accept the normal plant measurements such as flows, megawatts, megavars, pressures, and temperatures by means of electrical signals from transducers and measuring elements such as flowmeters, pressure transmitters and thermocouples in the following forms: 1. d-c voltage (10 volts nominal maximum), 2. d-c milliamp, 3. digital pulse, 4. therm-ohms, 5. a-c voltage (0-3 volts preferred minimum or 0-140 volts maximum), 6. contact closures.

Of the 396 available inputs (384 analog and 12 digital) we are presently utilizing 221 for the No. 1 unit, so that we have the capacity for the No. 2 unit without installing additional input equipment.

Signals enter the computer through the multiplexer mercury-wetted relays to analog-to-digital converters at a rate of five per second. The analog-to-digital converter reads the input value by allowing a capacitor system to be charged for a precise time interval, then an accurate counter charge is applied and the time interval required to discharge the capacitor circuit to zero is measured. This process is repeated 20 times during the 1/5 second allotted to each point with the first ten readings discarded to eliminate the effect of transients caused by the switching of the mercury-wetted relays. This procedure accounts for a large portion of the accuracy of this computer system.

Normally, in a computer of this size for a single unit, only one analog-to-digital converter is supplied; however, we purchased an analog-to-digital converter for the second unit at the time of the original purchase, and rather than have this extra device idle until required, the computer is programmed so that half of the plant readings will normally go through each converter; but if something happens to either converter, then all of the plant readings will be handled by the other converter automatically.

Actual plant inputs are shown on the page opposite.

DURING THE READING CYCLE, if any of the various plant inputs have an open circuit the computer will recognize this and signal on the alarm printer and the annunciator that an open circuit has developed; however, it will not do this until after it has rechecked the point for a second time.

This feature has already produced one interesting incident. During the connecting of the external thermocouples, the computer was checking to see that a signal was coming through. After the construction men had connected a thermocouple, the computer indicated that the circuit was open, whereupon the workman immediately conjectured that something was wrong with the computer.

However, he somewhat reluctantly went back to the terminal rack and opened the terminal block, checked the connection and found that nothing was wrong with the terminal connection at the terminal block. The computer, however, was still showing an open circuit for this thermocouple.

The workman was positive that the computer had made a mistake. After some discussion, he went to the thermocouple connection at the motor bearing, opened up this connection and found that somebody had made the connection at this point without stripping off the insulation. After this was corrected the computer then began reading the input value for this thermocouple.

Now, the workmen do not argue with the computer but rather methodically begin checking the wiring when the computer shows an open circuit.

PROGRAMMING of the computer is normally accomplished by a small keyboard located on the computer desk. The keys of the keyboard are appropriately labeled. The code of the key struck is taken into the computer and the value that the compu-

ter accepted is then printed on the computer input typewriter and also flashed on the display light panel just above the keyboard.

By this procedure, the typewriter furnishes a record of what has been programmed into the computer, while the display lights give the programmer a visual indication of the computer acceptance without having to read the typewriter which is located off to one side. These display lights can also be selected by appropriate switches to show the contents of any register, or analog-to-digital converter value for program "debugging."

Also, it is possible to program the computer by use of the computer input typewriter. The computer input typewriter has both a tape punch and a tape reader. After the appropriate code is punched into the tape, the tape is then fed into the typewriter tape reader and the computer will then read the tape and at the same time type out on the typewriter what the computer has accepted. By cross-checking the two typewritten copies, that is, during the tape punching and the tape reading, a check can be made to see that the computer accepted the correct program. This typewriter tape reader operates at approximately 10 characters per second, which is the same speed as the typewriter itself.

Also, the Ferranti tape reader, which utilizes light sensing of a prepunched tape, can be used to program the computer at the rate of 300 characters per second. This device is used to install a new program, or in the case of loss of memory of the program in the computer, it is used to reinstall the original program. If all the memory was in use during a program and the computer lost its memory, this device would reprogram the computer in 2.3 minutes, whereas the computer input typewriter would require 68.3 minutes.

The outputs of the computers are in six different forms; log sheets, punched tape, alarm printer, display lights, a three-pen miniature trend recorder, and annunciator drops.

We have presently selected 108 individual readings and calculations for logging. Fifty-six items will be logged on one typewriter and 52 items on another typewriter. This logging normally occurs at hourly intervals; however, the operator, by manipulation of the switches on the demand switch console, can demand a log at his pleasure. We expect this will take care of all the normally logged points.

AS A RESULTS COMPUTER the main computation is the unit net heat rate. By knowing what the instantaneous heat rate is at the time of operation, that operation can be adjusted to permit optimum operational efficiency, and it is by this method that we hope to realize a saving in fuel cost. Also, the unit heat rate is compared with a present heat rate and when the calculated heat rate exceeds the present heat rate, the alarm printer will print out the deviation so that adjustments can be made.

In order to give the operators a guide as to what is causing the excessive heat rate, boiler efficiency, turbine efficiencies, condenser efficiency, feedwater heater terminal differences, and air preheater efficiency are also calculated and available to the operators.

Plant data is averaged and/or totalized daily for historical and reporting purposes, which will free many man-hours a year for other duties.

When burning fuel gas, our calculations are based on the gas measurement, whereas when burning fuel oil, our calculations are based on the loss method. The feeling is that the normal fuel oil measurement methods are not accurate enough for the computer, whereas the fuel gas measurement is acceptable.

In all steam calculations, the primary measuring device is the feedwater flowmeter, and corrections are made to this measurement for the various cycle computations which are corrected for such items as boiler blowdown, steam to crossover heater, steam to air preheater, turbine leakage, saturated steam, etc.

Although in the main we are using this computer for a monitoring and results computer, we do plan to utilize the device for some control purposes. We are studying a plan to start and stop the cooling tower fans on a Marley 7-cell, induced-draft tower, according to the economics of fan operation as related to over-all plant efficiency. We expect that with this device we may be able to learn more precisely the effect of fans in plant operation and perhaps be able to furnish a guide as to fan operation for other towers on our system. END

ACTUAL PLANT INPUTS TO THE COMPUTER

FLOWS: fuel gas, fuel oil, condensate, feedwater, boiler blowdown, main steam temperature emergency spray, reheat steam temperature emergency spray, crossover heater drain, station desuperheater main steam supply.

PRESSURES: fuel gas supply, fuel gas burner, fuel oil burner, furnace, boiler drum, throttle, hot and cold reheat, intermediate turbine exhaust, extraction bleeds, condenser, feedwater, saturated steam, generator hydrogen, turbine bearing oil, turbine hydraulic oil, service water header.

TEMPERATURES: fuel gas, burner fuel oil, fuel oil burner pump suction, main steam, hot and cold reheat, intermediate turbine exhaust, turbine exhaust, hotwell, extraction steam, condensate and feedwater out of heaters, extraction heater drains, saturated steam (station desuperheater out), circulating water (in and out of condenser), ambient air (wet bulb and dry bulb), windbox.

Air-to-air preheaters, air from air preheaters, flue gas from air preheaters, flue gas to air preheaters, generator hydrogen, hydrogen gas to coolers, hydrogen gas from coolers, exciter air out, generator stator, generator rotor, main power transformer, auxiliary transformer, standby transformer, turbine oil coolers (water in and out), turbine oil coolers (oil in and out), thrust bearing, front and rear drain, thrust bearing metal (front and rear), turbine-generator bearings, exciter bearing oil drain.

Superheater tube metal, reheater tube metal, steam chest, turbine HP bolt and flange, exhaust hood, boiler feed pump and motor bearings, forced-draft fan and motor bearings, circulating water pump motor bearings, condensate pump motor bearings, fuel oil burner pump motor bearings.

Fuel oil differential pump motor bearings, LP heater drip pump motor bearings, instrument air compressor motor bearings, station air compressor motor bearings, vacuum pump motor bearings, air preheater bearing oil, oil from air side seal oil cooler, oil from hydrogen side seal oil cooler.

ELECTRICAL: integrated generation and station uses, generator and exciter volts and amps, transmission lines MW and MVAR.

CONDUCTIVITY: condensate (condenser out), saturated boiler steam (provision for superheat), boiler blowdown, demineralizer effluent.

pH: condensate (condenser out), feedwater (deaerator out), demineralizer effluent.

MISCELLANEOUS: fuel gas Btu per cubic foot, fuel gas specific gravity, oxygen in flue gas, carbon dioxide in flue gas, combustibles in flue gas, speed and governor valve position, spindle position, spindle vibration and eccentricity, cylinder expansion, differential expansion.

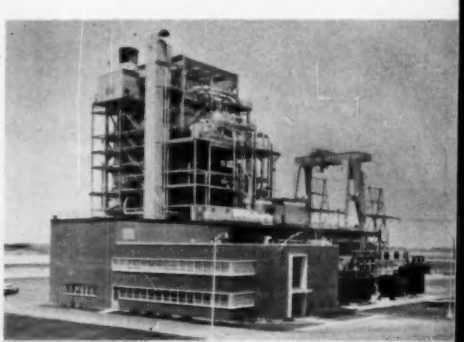
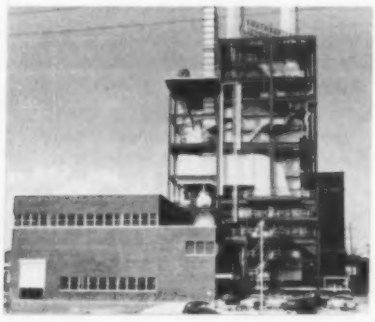


Fig. 3. Gordon Evans Steam Electric Station has a No. 1 unit of 160,000-kw capability, steam generator of 1,020,000 lb/hr

PEAKING PLANT USES SPRAY COOLING

Terral Whetstone, of Southwestern Electric Power Co., describes specially designed peaking unit



VALUABLE EXPERIENCE in operating a peaking plant was provided by Arsenal Hill Unit No. 5. Initial acceptance test took place in February of 1960, and the unit was declared available for commercial operation on April 1, 1960. It has been operated intermittently since then during the summer months of June, July, August and September.

Type of equipment selected and installed was based upon the fact that it would be used primarily during peak load periods and during emergencies. Another factor affecting the selection of the equipment was the assumption that the unit would experience a large number of start-ups and shutdowns. The equipment was designed for many overnight and week-end shutdowns.

General Electric supplied the turbine, which is a 3600-rpm, 100-Mw, tandem compound, double-flow, nonreheat unit. Design steam conditions are 1450 psig and 1000 F, and exhaust pressure is 3½-in. Hg abs. An outstanding feature of the turbine is provision for full-arc admission, which has been incorporated into the design. This allows a shorter start-up period with a minimum of thermal stress to the high-pressure shell and nozzle block.

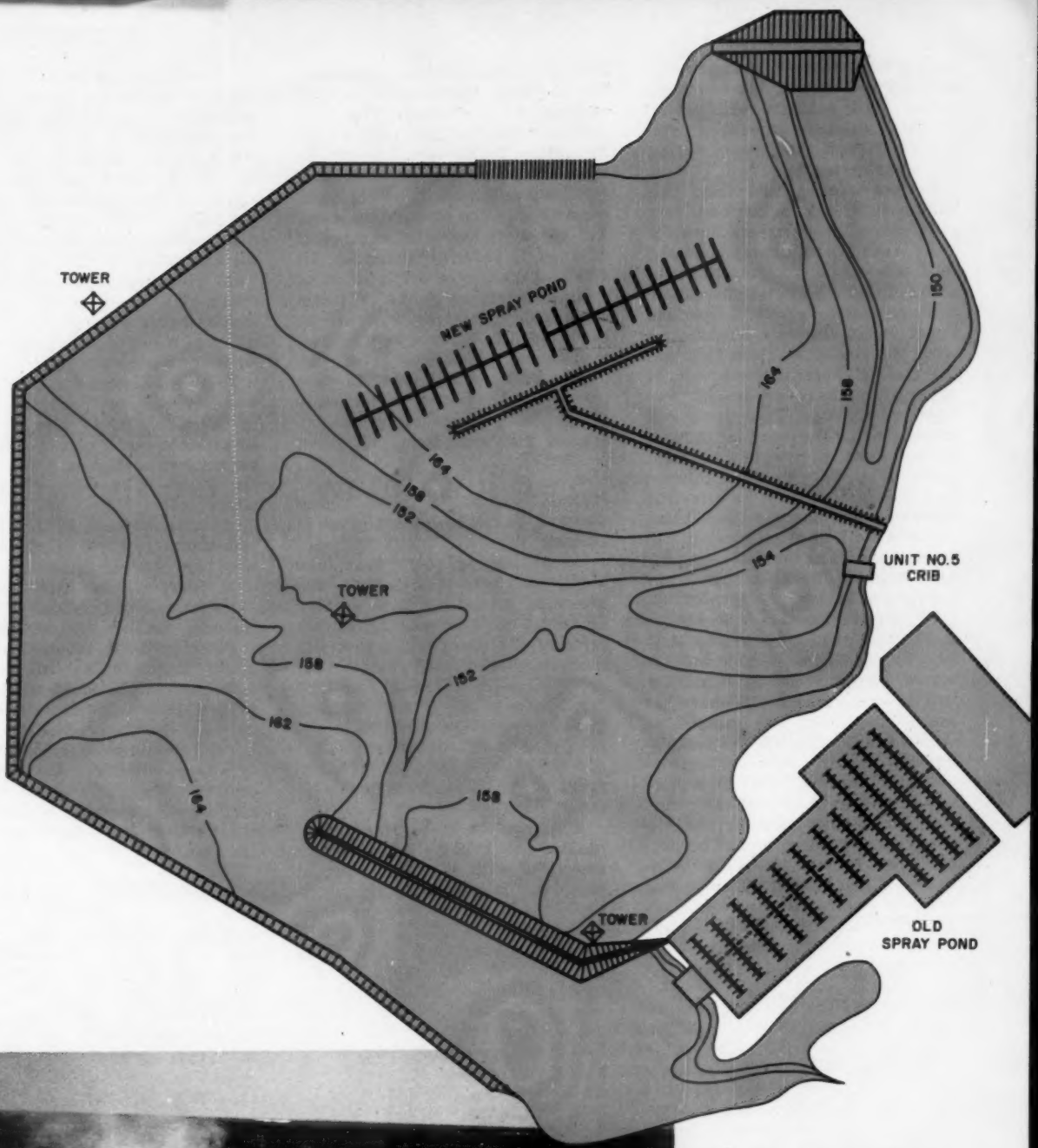
Combustion Engineering supplied the boiler. This tangentially fired gas burning unit is rated 810,000 lb/hr with final superheated steam conditions of 1500 psig and 1005 F. The superheater arrangement was designed so that all of the superheater elements and all of the superheater headers would be completely drainable.

Boiler controls are both electric and pneumatic. Leeds & Northrup's motor operated system was selected for the combustion controls, and Bailey Meter Company furnished their pneumatic system for the steam temperature controls. Republic's three-element feedwater control is used.

WHY SPRAY PONDS? In recent years the trend of the power industry has not been toward, but rather away from the use of spray ponds. It is believed that our spray pond installation has been the first central station power plant application in several years. Perhaps a cooling tower would have been utilized had it not been for the economic savings and advantages in the physical layout of the spray equipment chosen for Arsenal Hill Unit No. 5. The spray system as it now exists, consisting of an old spray pond that was installed in 1925 and a new spray pond which was installed along with Unit No. 5, is designed to handle approximately 70,000 gallons of cooling water per minute. The lake in which the spray equipment is located has a surface area of 37 acres at its normal water elevation of 168 feet, and it contains a storage capacity of 310 acre-feet at the same elevation.

Before Unit No. 5 was installed, two of the four old units located at this plant site took their cooling water from a bayou running adjacent to the lake and plant property. By using part of the original circulating water system to the old units, provisions were made to fill the lake with bayou water or to add make-up as the situation demands. However, during most of the summer the bayou is rather stagnant and the water is very high in chlorides and hardness, which makes it unsuitable for use as cooling water.

Because of this fact facilities are available for raw water to be pumped from the city water main. A quantity of water will normally



Schematic diagram shows configuration of old and new spray ponds. Photo shows new pond and Unit No. 5 crib

have to be purchased from the city each summer during the operating period. This quantity will depend primarily upon the amount of rainfall and run-off that occurs during this same period.

Performance realized from this cooling water system has been very satisfactory. During the summer of 1960, Arsenal Hill's spray pond and small lake actually performed better than did Caddo Lake, which supplies cooling water to our Lieberman Power Plant. However, at the same time, one is aware of the fact that the cooling water system will be subjected to more severe and continuous service as the system load grows. During the past year the unit has only been required to carry light loads during the day and minimum load at night. Still it is felt that the lake performance witnessed this past year is indicative of what will be experienced as the generation requirements for this unit grow higher and higher.

A performance test was run on the cooling water system on July 27, 1960, to determine how well the system was functioning. This day was chosen because it was one of the hottest days that was experienced during the summer. On this particular day the dry bulb temperature was 95 F, the wet bulb temperature was 80 F, the circulating water inlet temperature was 92.5 F, and the wind velocity was 5 mph. The generator was fully loaded by 8:30 A.M. so that a maximum amount of heat could be rejected to the lake before taking any test readings, thus making the operating conditions as adverse as possible.

TEST RESULTS. The data was collected during the hottest part of the afternoon, from 1 to 2 P.M. The results of this test show that the spray pond had a 17 F approach to the wet bulb temperature when the circulating water temperature to the sprays was 107.5 F. Calculations made from this data indicate that 75 per cent of the cooling effect could be attributed to the sprays and the remaining 25 per cent cooling effect could be credited to surface evaporation from the lake.

One of the main objections to the use of spray ponds has been the assumption that the evaporation losses are too high, but this has not been true of Arsenal Hill's cooling water system. During the summer of 1960, make-up water was added to the lake only one time. The amount of make-up water will depend upon the amount of steam condensed, the quantity of rainfall and run-off, and the day to day weather conditions. The variables that were taken into account in determining the total losses for this particular spray pond installation were the quantity of make-up water and the amount of rainfall and run-off. The total losses consisting of the evaporation losses and the drift losses for the period of June 1, 1960, to September 23, 1960, amounted to 0.7 pounds of cooling water per pound of steam condensed. This spray pond will be called upon to carry a heavier heat load as the system load growth demands Unit No. 5 to generate more power, but the cooling water losses will be expected to remain at 0.7 pounds per each pound of steam condensed.

PEAKING CAPACITY. Today almost everyone seems to be interested in peaking capacity. Many different types of peaking plants have been studied and many papers have been presented concerning these studies. So far no one has been able to conceive of a peaking plant that will meet every need and be suitable for every situation. Arsenal Hill Unit No. 5 is one type of peaking unit. It has been in operation for over a year, and much valuable experience and information has been gained in operating this particular type of peaking unit.

What can one expect this type of peaking unit to cost? All of the cost associated with this unit must be considered in answering this question. Unit No. 5 including the power transformer, reservoir, land, and offices was installed for a total investment cost of $10,130,000. If the summer rated capability of 116 Mw is used for a basis, an initial investment cost of $87.33 per kw of capability will result. This figure is slightly higher than our previous total investment cost in dollars per kilowatt capability; but at the same time it is about $13 per kw of capability cheaper than a reheat, base load unit would have been had the reheat machine been purchased at the time that Unit No. 5 was purchased.

Fixed charges on all of the units amount to approximately 14 per cent of the total investment cost per year. During 1960 Unit No. 5 had a yearly load factor of 9.19 per cent, and the generation for the year was 90,783,900 kwh. The fixed charges on Unit No. 5 amounted to 15.62 mills per net kwh generated for the year, which seems to be rather high, yet the fixed charges on an equivalent reheat unit operating at the same load factor would have cost 17.65 mills per net kwh. Normally, the fixed cost is the primary determining factor of the total operating cost. However, in the case of Unit No. 5 the fuel accounted for about half of the operating cost due to the extremely low generation for the year. Even so, the fuel cost was still high because of an actual heat rate for the year of 12,050 Btu per net kwh. This high heat rate was the result of a large amount of light load operation and the fact that the unit was required to make 33 normal start-ups during the year.

Total power cost for Unit No. 5 was 5.17 mills per net kwh neglecting fixed charges as compared with an expected power cost of 4.91 mills per net kwh neglecting fixed charges for a reheat machine. This total power cost for Unit No. 5 is not quite true because all of the expenses incurred by the entire station have been charged against the single unit. There are also four additional units located at this station which ran only one time during 1960.

Prior to the installation of Unit No. 5 it took 21 men to maintain and operate these four units. At the present time only 28 men are required to constitute adequate operating and maintenance forces. In reality a large portion of the operating cost, excluding fuel and maintenance cost, would have been present even though Unit No. 5 had never been installed.

NON-REHEAT WINS. It can readily be seen that the non-reheat machine was more economical than a reheat machine would have been, when the fixed charges are added to the total power cost. Also, it should be pointed out that the operating cost in mills per net kwh for Unit No. 5 was 2.4 times as much as the average operating cost of the other units in the system. Of course, as our system load grows, Unit No. 5 will generate more kilowatt-hours during the year at a higher load factor, and total production costs will be reduced considerably.

This unit has proved to be rugged, dependable, and easy to operate. Performancewise it has met all expectations and in some areas it has performed better than was expected. It is felt that a unit of this type has a definite place in the system, and that future operations will continue to prove that there is a need for such a unit.

Editor's Note: A complete description of this plant's operation was given in a talk by the author at the Missouri Valley Electric Association Meeting, April 1961. END

THREE SOURCES OF POWER AT ONE SITE

Atoms, coal and water will be energy sources for Carolinas Virginia complex

FIRST INVESTOR-OWNED nuclear power plant in the Southeast is taking shape near the town of Parr, South Carolina. This site, not far from Columbia, soon will be the only place where electricity is produced from water, coal and nuclear fuel in adjoining power stations.

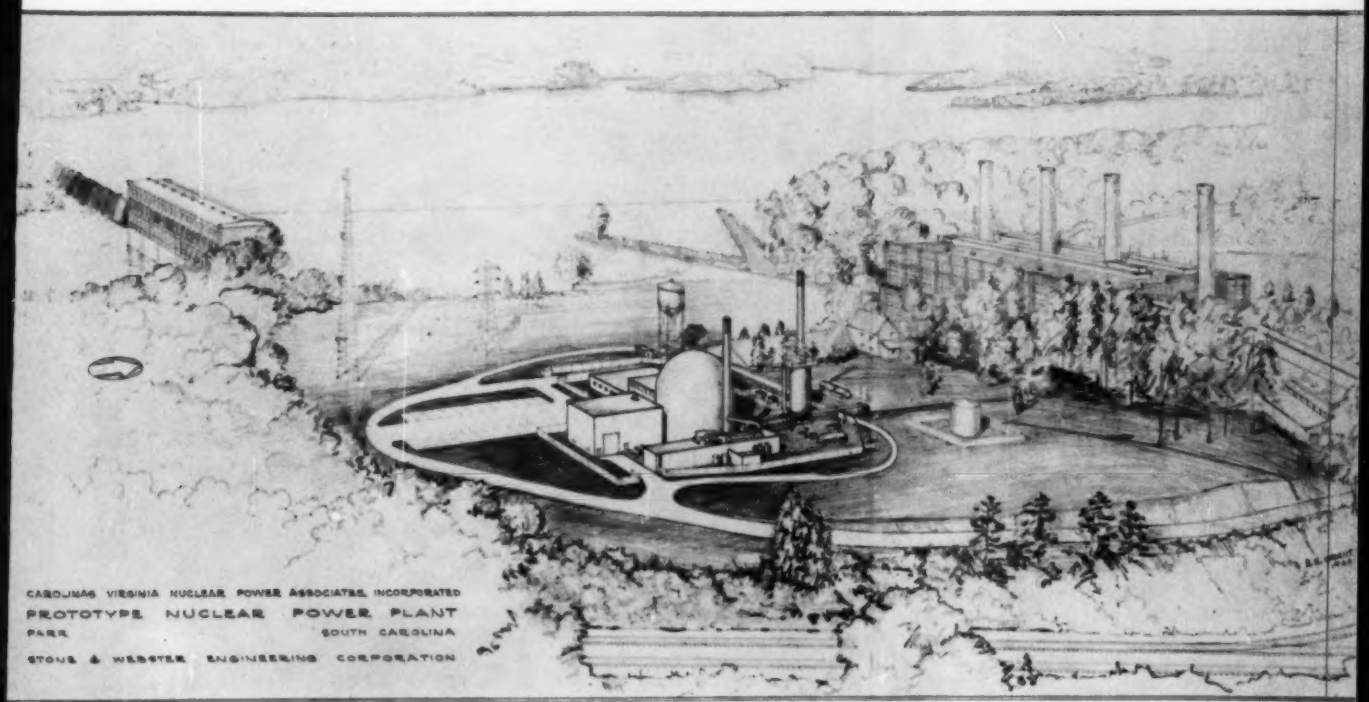
This 17,000-kw atomic plant—due for completion in mid-1962 — will be flanked by a hydroelectric station and a coal-fired, steam-electric plant, operated by South Carolina Electric & Gas Co., one of the atom project's sponsors.

Stone & Webster Engineering Corporation, veteran planner and builder of nuclear facilities, designed the $19 million plant for four electric utilities which have formed Carolinas Virginia Nuclear Power Associates, Inc. Members, besides South Carolina Electric & Gas, are Carolina Power & Light Co., Duke Power Co. and Virginia Electric & Power Co.

The atomic plant will contain a prototype reactor, first of its kind installed in a U.S. nuclear power station. The reactor is described by Stone & Webster as a pressure-tube type, fired by uranium dioxide, and cooled and moderated by heavy water.

Steam produced by the reactor will be piped to the nearby thermal station, which generates power for a 23-county area served by the four Power Associates. END

Artist's conception of the unique three-plant complex, using hydro, steam and nuclear energy


CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INCORPORATED
PROTOTYPE NUCLEAR POWER PLANT
PARR SOUTH CAROLINA
STONE & WEBSTER ENGINEERING CORPORATION

AIRLIFT SPEEDS TOPPING OUT OF TRANSMISSION TOWERS

Helicopter carries and positions 1200-lb steel sections in over-water job in Oregon

PACIFIC POWER & LIGHT CO. has used a combination of helicopter and barge-mounted crane to build two 200-ft transmission towers in Coos Bay, Oregon. The towers span 115,000-volt lines across a 1200-ft wide shipping channel in the Bay.

Topping out the first tower from the 111-ft level until the last insulator was bolted in place, took only 4½ hours of flying time by the 305-hp Hiller 12E helicopter, which itself weighs only 1700 lb.

According to officials of the power company, Tyee Construction Co., and Columbia Helicopters, this was the first time a light helicopter had been used to erect a heavy steel structure, and the first time an airlift had been used over water in the Pacific Northwest.

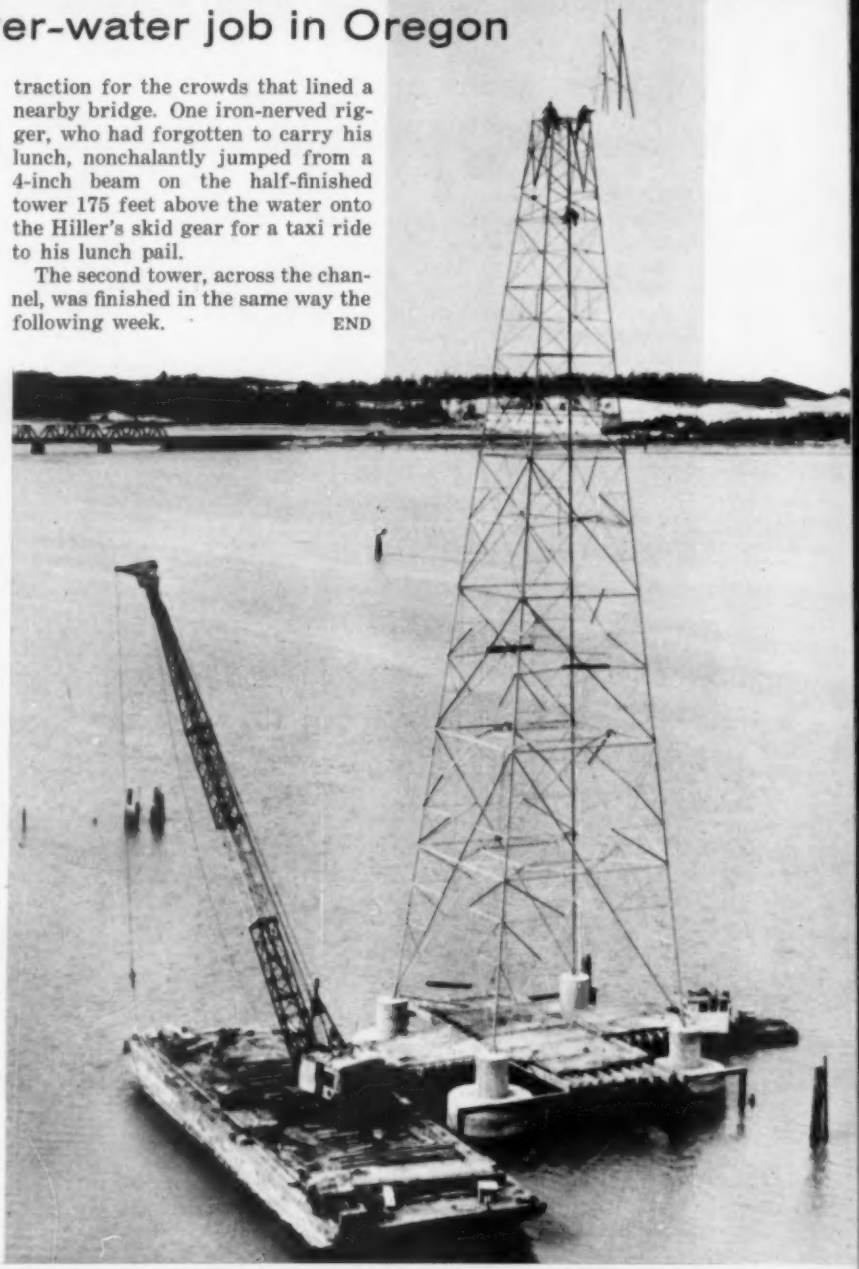
After a barge-mounted crane had erected the lower 111 feet of the tower on concrete footings, the remaining pre-built sections, ranging in weight from 500 to 1200 lb, were laid out in order of assembly on the nearby shore about 1000 yards from the tower.

As the Hiller hovered low over the staging area, the ground team hooked each steel section to its cargo hook. Above the tower, the copter hovered steadily with each steel section as the rigger's arm signaled into position. Once the assembly was bolted in place the pilot pressed the electrically controlled cargo hook release and flew back for another load.

Average time for each delivery round trip was under five minutes. Thirty structural assemblies plus insulators were delivered in this way in some four hours of flight time. Conventional gin pole practice would have required an estimated five days.

The most powerful helicopter in its class was not the only star attraction for the crowds that lined a nearby bridge. One iron-nerved rigger, who had forgotten to carry his lunch, nonchalantly jumped from a 4-inch beam on the half-finished tower 175 feet above the water onto the Hiller's skid gear for a taxi ride to his lunch pail.

The second tower, across the channel, was finished in the same way the following week. END



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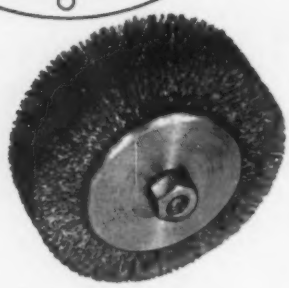

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new power construction

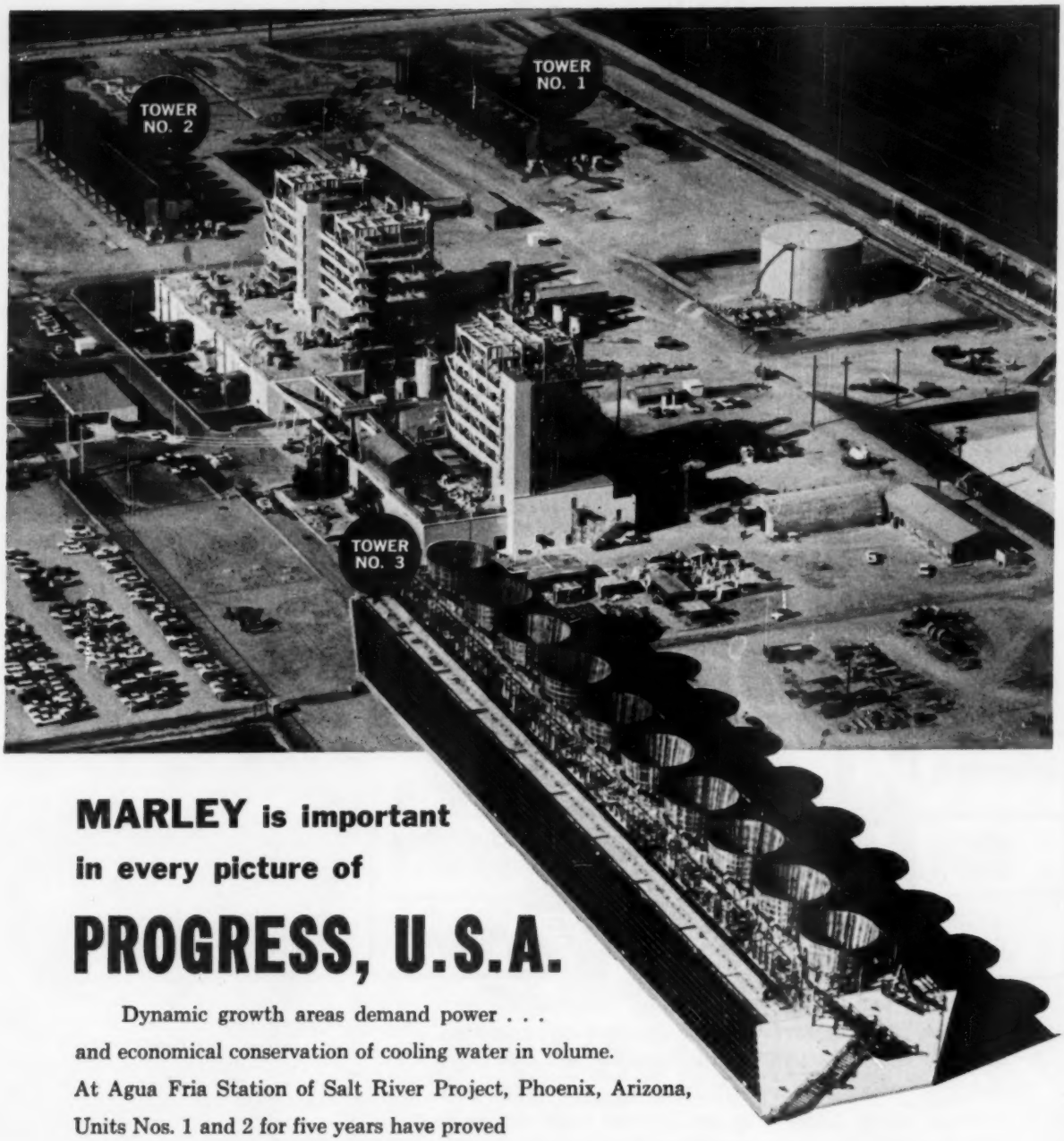
Hawthorne, Calif.—Northrop Corp., Beverly Hills, Calif., has announced that it will build a 100-kw nuclear reactor for experiments with the effects of radiation on space-exploration vehicles. Company proposes to construct the reactor at its plant located here and has awarded a contract to the General Atomics Div. of General Dynamics Corp., San Diego, Calif., for the work, which will begin at once. Permission for the plant has already been granted by the Atomic Energy Commission.

San Francisco, Calif.—Pacific Gas & Electric Co., 245 Market St., has authorized plans to construct a huge atomic power plant at Bodega Bay, Sonoma County, 50 miles north of here. Proposed plant will have an electric generating capacity of 325,000 kw to provide service for a city of 500,000. The reactor for the plant will cost $59,000,000 and other station costs another $2,000,000, for a total of $61,000,000. In addition $2,750,000 will be spent for transmission lines and terminal facilities. Construction of the new facility will begin in August 1962, with completion scheduled for December 1965. It is reported that electricity produced at the plant will cost slightly less than 0.6 cents per kwh, about the same as the cost of generating electricity by conventional means.

Versailles, Conn. — Federal Paper Board Co., 24 River Road, Bogota, N.J., has announced the beginning of a major expansion program of company facilities to be financed by a proposed offering of $20,000,000, sinking fund debentures. Company has authorized plans for the construction of a new paperboard mill and power plant at this location.

Jefferson, Ga. — Jackson Electric Membership Corp., headquartered here, has authorized plans for the expenditure of approximately $1,500,000 for the construction and installation of new transmission and distribution lines and necessary substations covering rural sections in Jackson, Lumpkin and Madison Counties, which it serves. Work on the new lines will get under way at once for completion scheduled by the spring of 1963. Southern Engineering Co., Atlanta, Georgia, is consulting engineer.

Milledgeville, Ga. — Georgia Power Co., 15 Forsyth St., S.W., Atlanta, Ga., has authorized plans by Southern Services, Southern Co., 1330 W. Peachtree St. N.W., also of that city, for the construction of a new power plant on Lake Sinclair, near this place. New project will be known as the Sinclair Dam Plant and will have a steam-electric generating capacity of 250,000 kw. Work on the new unit will begin at



MARLEY is important in every picture of

PROGRESS, U.S.A.

Dynamic growth areas demand power . . . and economical conservation of cooling water in volume. At Agua Fria Station of Salt River Project, Phoenix, Arizona, Units Nos. 1 and 2 for five years have proved the practicality of big per cell capacity cooling towers teamed with big capacity turbines. A Marley Class 600 Double-Flow was recently supplied to furnish condensing water for the 168-mw Unit No. 3. It is the largest machine served by a single-structure cooling tower and, says T. M. Morong, Chief Engineer, "Tests indicate it is contributing to our having a plant that more than meets design criteria." It also contributes economy in required plant area, piping cost and maintenance.

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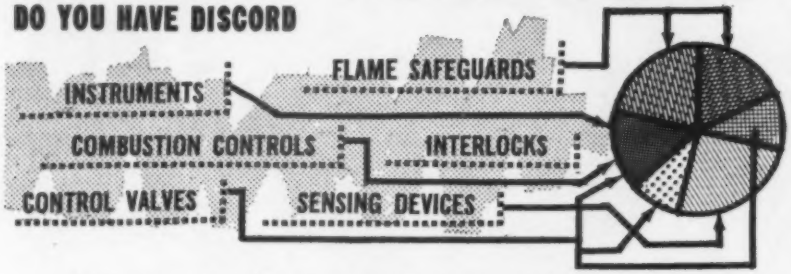
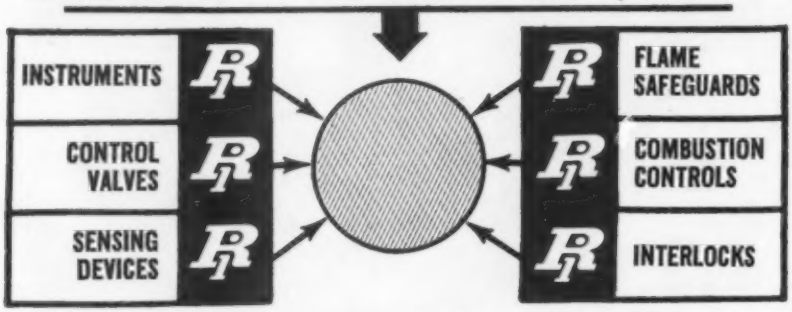


When you use subsystems and components by six different manufacturers it's a real headache to coordinate and integrate—to form the fine, smooth functioning system you want. Even buying "unit responsibility" from a single manufacturer often means that you're paying overlapping profits and getting "underlapping responsibility."

Field service costs soar when un-coordinated subsystems clash at assembly and client relations deteriorate at an amazing pace.

OR **HARMONY**. . . *with coordinated components?*



Now you can avoid those hidden incompatibilities—eliminate the constant fear of overlooking something. Reliance Instrument offers **complete** systems with single manufacturing control over all subsystems and components. Years of study, adaptation and product improvement insure that Reliance coordinated components go together like steak and mushrooms. There's no longer any need for hectic, time-consuming matching of units because Reliance supplies everything including the pipe and the wire.

So take a vacation from spec-writing woes. Let the systems engineering specialists at Reliance analyse your problem. You'll be pleasantly surprised how coordinated components can simplify your spec. And remember—cost is low when you cut out overlapping profits.

RELIANCE INSTRUMENT
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Division of **ELECTRO-MECH** Corp.
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once for completion in about two or three years. Project when completed will represent an investment of approximately $42,000,000.

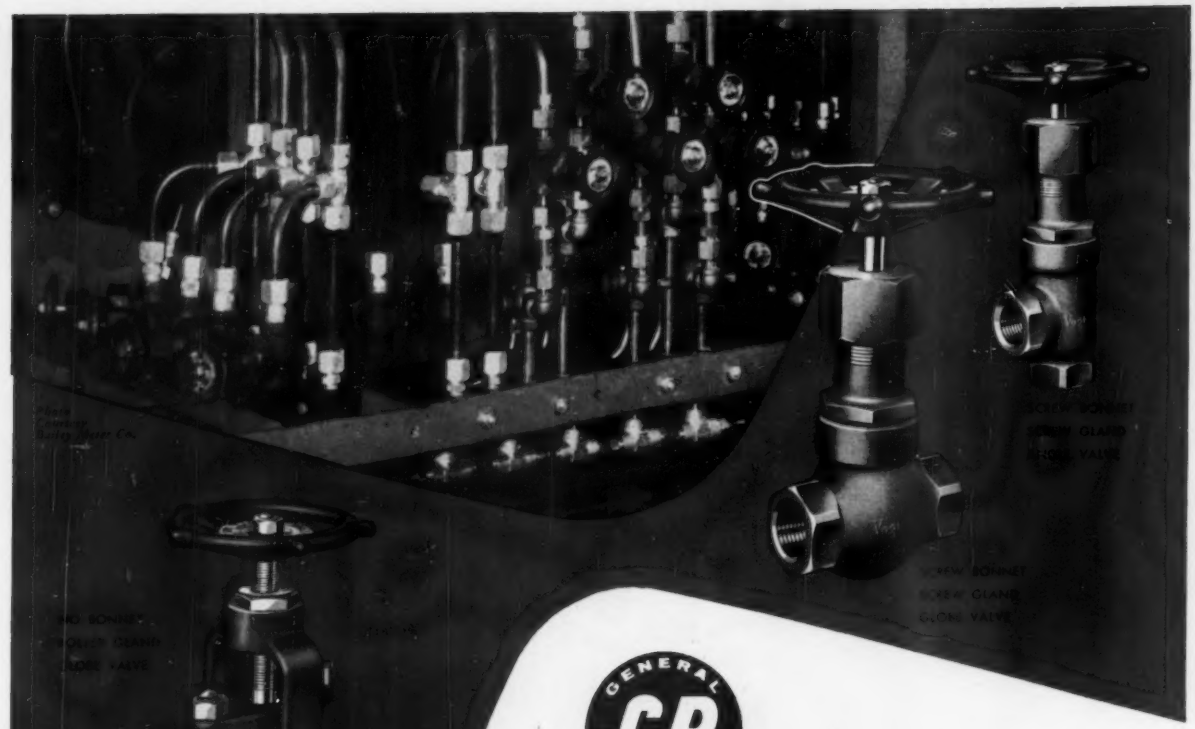
Chicago, Ill.—Commonwealth Edison Co., 72 West Adams St., this city, has authorized plans for the expenditure of approximately $720,000,000 for new equipment and construction of increased generating capacity through 1965. The utility had reported earlier that it originally planned to spend $640,000,000 through 1964. Company was able to defer some equipment purchases until 1965 by purchasing power from other systems. Program calls for expenditures of $155,000,000 in 1961; $140,000,000 in 1962; $138,000,000 in 1963; $145,000,000 in 1964; and $150,000,000 in 1965. Other projects planned will boost net generating capability to 7,606,000 kw by the end of 1965, from the present 5,511,000 kw.

Petersburg, Ind.—Hoosier Cooperative Energy, Inc., Osgood, Ind., has approved plans and will start construction soon on a large new steam-electric generating plant on a large site recently acquired near here. Plant will be equipped with a steam-electric generating unit with an initial capacity of 198,000 kw along with high-pressure boilers and auxiliary equipment. Plans also include the construction of 1500 miles of 154-kv and 69-kv transmission lines and necessary substations. Plant is scheduled for completion late in 1963 at a cost including the transmission facilities of $60,225,000.

Owensboro, Ky.—City Utility Commission of Owensboro, 412 Frederica St., has announced plans to construct a two-story municipal power plant two miles east of this city. Plant will be equipped with a steam-electric generating unit with an initial capacity of 125,000 kw, along with high-pressure boilers and auxiliary equipment. Work on the new project will begin soon for completion by 1963 at a cost in excess of $25,000,000.

Framingham, Mass.—Commonwealth of Massachusetts, Department of Education, Division of Building Construction, 38 Chauncy St., Boston, Mass., has authorized plans for a major expansion and improvement program to existing power plant located at State Teachers College, here. Plans call for the installation of equipment for increased capacity and modernization of existing equipment.

Minneapolis, Minn.—Northern States Power Co., 15 S. Fifth St., this city, has announced plans and will start work soon on the construction of a 135-mile, 115,000-v power line in conjunction with Minnesota Power & Light Company, Duluth, Minn., and Otter Tail Power Company, Fergus Falls, Minn. The lines, which will cost in excess of $3,000,000, will connect the systems of the three companies, a step toward integration of Minnesota power company systems



GENERAL GP PURPOSE

FORGED STEEL *INTEGRAL SEAT* METER AND GAUGE LINE VALVES

Union Bonnet, Screw Bonnet and No Bonnet Types

Service proved Vogt GP Forged steel valves are the choice of leading meter and gauge Manufacturers for top performance and unfailing reliability.

They are available in sizes from ¼" to 2" of carbon steel for general purpose duty and of all-stainless where highly corrosive liquids are involved. All stems are one-piece 13% Chrome Stainless Steel with fine pitch threads for accurate regulation of flow. Special packing is furnished when specified.

Catalog F-10 contains the complete Vogt line of valves, fittings, flanges and unions. Available upon request on your letterhead. Address Dept. 24A-FPE

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FORGED STEEL **VALVES, FITTINGS, FLANGES and UNIONS**

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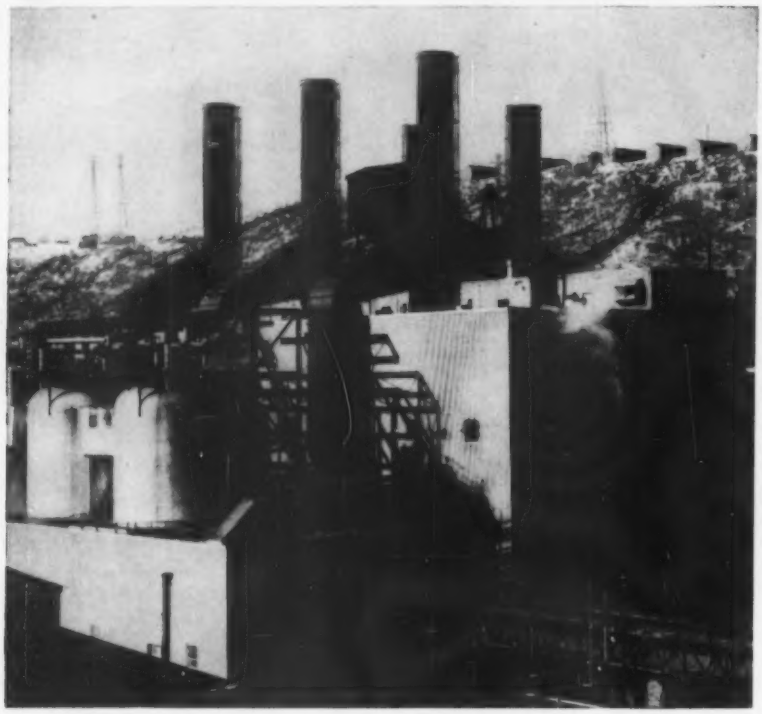
HOW HAGAFILM® ELIMINATED $10,000 A YEAR POWER PLANT CORROSION COSTS



Quick case history—reading time 52 seconds

THE PLANT: Large power station serves U.S. Steel's National Tube Division at McKeesport, Pa. Monongahela River water is used for boiler make up.

River water is clarified with Hagan Coagulant Aid and alum, softened with lime and soda ash and deaerated for use in boilers. Desuperheating condensate system was forecast as corrosion weak spot because of high CO_2 in steam. To evaluate cost of maintenance versus treatment, National Tube engineers adopted a "wait and see" policy.

THE PROBLEM: Magnitude of corrosion was almost unbelievable. Standard 1" x 2" x 20 gauge carbon steel test strips pitted through within 24 hours. Low pressure heater shells had to be continually patched. Spill-over lines and fittings failed almost weekly. Maintenance costs rocketed to a high of $10,000 a year.

THE SOLUTION: Treatment with Hagafilm reduced corrosion rate from a no treatment level of 1285 to less than 1 mg/dm²/day with a 4 ppm feed; and to a range of 5 to 10 mg/dm²/day with a 2 ppm feed. Present feeding is 3 ppm.

RESULTS: Since introduction of Hagafilm four years ago, no failures have occurred in spill-over system lines and fittings. Corrosion in entire system has been arrested.

National Tube engineers say that Hagafilm treatment has already paid for itself many times over in reduced labor and maintenance costs.

FOR FULL INFORMATION on Hagafilm, write for free Bulletin 410-12-7.

HAGAN
CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN DIVISIONS: CALGON CO.–HALL LABORATORIES–BRUNER CORP.

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to create a statewide grid. The grid is part of a larger pool, Upper Mississippi Valley Power Pool, formed early in 1961. Included in the larger pool are the three Minnesota companies and Interstate Power Co., Dubuque, Iowa, and Dairyland Power Cooperative, La Crosse, Wis.

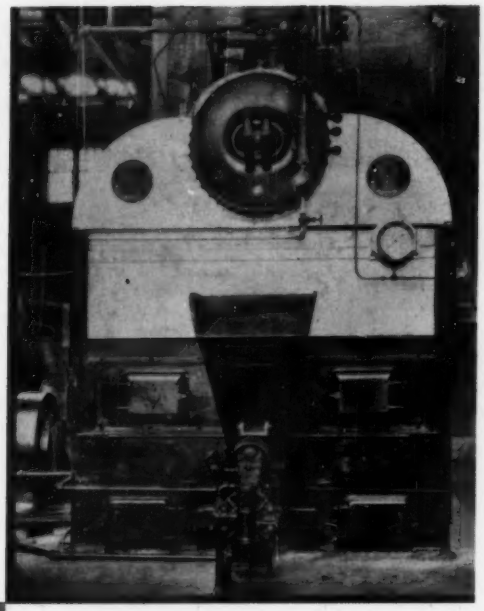
Ridgefield, N.J.—Public Service Electric & Gas Co., 80 Park Place, Newark, N.J., has announced that it has placed in service a performance computer which will monitor the efficiency of two huge steam-electric generating units at its Bergen Generating Station located here. One of the aims is to reduce the fuel bill for the giant station with two giant generating units, each capable of producing 290,000 kw. The transistorized digital computer, manufactured by Leeds & Northrup Co. under an agreement with the Philco Corp., took two years for design, production, programming and final installation. New installation will record such data as the amount of coal being used, temperatures, pressures, flows and the amount of electricity produced.

Fargo, N.D.—State Board of Higher Education, Bismarck, N.D., has announced contract award to the Moorhead Machinery & Boiler Co., 3477 University Ave., N., Minneapolis, Minn., to furnish and erect a steam generating unit at the State University of Agriculture and Applied Science, located here. Work on the new installation is already under way and is scheduled for completion by late 1962 or early 1963. Cost of the installation reportedly will be about $225,000 when completed.

Conesville, O.—Columbus and Southern Ohio Electric Co., 217 Front St., Columbus, O., has authorized plans to install equipment for increased capacity at its Conesville Power Station, located here. Company has awarded contract to the Dravo Corp., Pittsburgh, Pa., for the work, which will begin at once and will include the installation of a third steam-electric generating unit with a capacity of 125,000 kw. Project, which will represent a multimillion dollar investment, is scheduled to be completed early in 1963.

Byran, O.—City Department of Lighting, City Hall, has approved plans for the proposed expansion of the municipal power plant and will proceed with the work at once. Installation will include a new turbine unit with auxiliary equipment. Entire project reportedly will cost close to $1,500,000 when completed in 1962.

East Palestine, O.—The Department of Power & Light of the City of East Palestine, City Hall, has authorized contract award in the amount of $327,120 for the installation of a steam-electric generating unit with an 80,000-lb boiler at the municipal power plant located here, to Babcock & Wilcox Co., 2730 Koppers Building, Pittsburgh, Pa.



THE FIRST
KEELER
TYPE CP
STEAM
GENERATOR

Installed in 1936 at the
Crystal Laundry in
Frederick, Maryland

THE FIRST **KEELER CP**

...still delivering trouble-free service with minimum maintenance after 25 years of continuous operation

Here's what Crystal Laundry general manager A. C. Thomas has to say about the Keeler CP which serves his firm's requirements . . .

"This boiler has been so entirely satisfactory that if it was necessary to replace it, we would buy another Keeler. It has been very dependable."

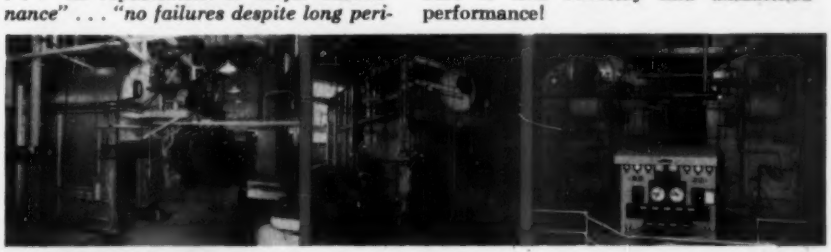
This Keeler CP Steam Generator *first* introduced furnace water wall design—*the first* boiler to offer large power plant reliability and economy in low-cost, factory assembled form. The CP design provides greater steam capacity per cubic foot of space occupied, greater furnace volume with less head room and more BTU's per square foot from radiant heat.

Other owners of 25-year old Keeler CP's report *"complete satisfaction on all points"* . . . *"no replacement or major maintenance"* . . . *"no failures despite long periods of over-rating operation"* . . . *"both units in service at full pressure"* . . . *"good dependable performance, producing far in excess of rating"* . . . *"well pleased with low operating and maintenance costs"!*

This type of steam generator economy and reliability is available in capacities up to 150,000 lb stm/hr—for all methods of firing, all types of fuel (and readily convertible). *Write or phone for full information* . . . insist upon Keeler quality to be sure of true economy and unmatched performance!

recent CP installations

A three-unit oil fired installation at an eastern high school; one of two stoker fired units at a midwestern college; and a two-unit gas fired installation at a tobacco processing plant.



The Seal of Quality in Water Tube Steam Generators

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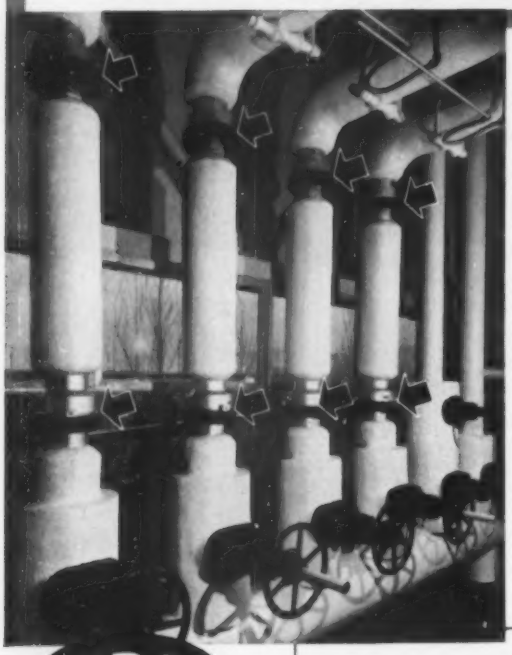
Barco Solves Valve Piping Expansion Problem



Relieves Strain on Valves

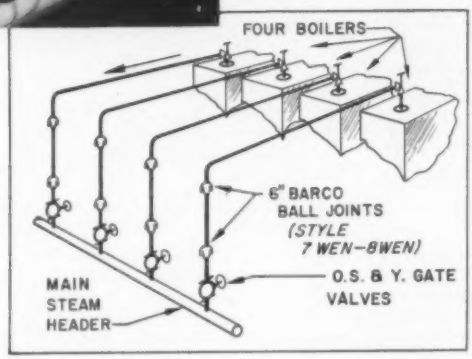
This photograph shows an interesting new installation of eight Barco Flexible Ball Joints (see arrows) on four 250 psi boiler steam lines in a West Coast industrial plant. The schematic diagram (below) shows the piping layout.

Due to the fact that operation of individual boilers is intermittent, complicated expansion, contraction, and torsional movements occur in the piping. All of these movements are easily accommodated with the aid of the Barco Joints, relieving reactive forces on the valves.

BARCO

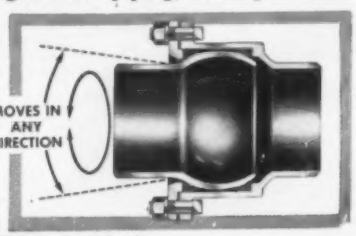
BALL JOINTS

1. Handle Expansion
2. Relieve Torsion
3. No "End Thrust"



PROBLEM—Originally, in the plant shown above, it was thought that the "spring" in the long runs of piping would take care of *thermal expansion* and *torsional stresses*. SUCH WAS NOT THE CASE. Serious trouble was encountered, tending to crack valve flanges and twisting so they would not seat tight.

ANSWER—Barco Ball Joints solved the problem, LOGICALLY, SIMPLY, ECONOMICALLY. These rugged all-steel joints have no thin wall sections, no critical points of fatigue, no rubber seals. They are practically indestructible. They provide points of flexibility in piping. Easy to engineer. They fit right in the piping; develop no "end thrust"; require no expensive anchoring. Sizes and styles to meet your requirements. *Send for catalog and information.*



BARCO MANUFACTURING CO.
547K Hough Street, Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal

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Preliminary engineering work is already under way, and construction of the unit will begin soon. New facility is scheduled for completion by the fourth quarter of 1962.

Round Butte, Ore.—Portland General Electric Co., 621 S.W. Alder St., Portland, Ore., has announced contract award to the Allis-Chalmers Manufacturing Corp., Milwaukee, Wis., for turbines and generators to be installed at the utility's Round Butte Dam, located near here. Contract for the cost of the equipment is estimated at $4,000,000. Included are three turbines, which will develop from 115,000 to 140,000 hp depending on the height of the water behind the dam, and three generators rated at 82,350 kw each. The turbines will be produced at Allis-Chalmers' York, Pa., plant and the generators at West Allis, Wis. Delivery of the equipment is slated to begin in the latter part of 1962.

Knoxville, Tenn.—Tennessee Valley Authority, New Sprankles Building, this city, has announced a new lower rate for electric power. The TVA Power System sells electricity at wholesale to 102 municipally owned power systems, 51 rural electric cooperatives and 2 private utiities. These organizations then sell the power to their respective consumers at rates agreed on in contracts with TVA. Such contracts until now have allowed for three different retail rate levels, and the new action provides a fourth rate level, the lowest of all. The new rate, while benefiting all users in areas served by systems that adopt the rate, would provide a proportionately larger benefit for consumers using between 250 and 900 kilowatt-hours a month. The Authority estimates savings to consumers of about $35,000,000 a year.

Henderson, Texas—Rusk County Electric Cooperative, Inc., 107 N. Jackson St., this city, has announced plans for a major expansion and improvement program of its system. Work will include installation of new transmission lines and construction of two new power substations. Work will proceed at once and is scheduled for completion late in 1962. Cost of the work is reported to be approximately $500,000.

COAL - from mine to boiler

Here's an up-to-the-minute picture of power at work on coal in underground mining, strip mining, hauling and unloading, storage and final handling at the power plant. Six articles now available in an attractive POWER ENGINEERING reprint. Write the Editor for a free copy; 308 E. James St., Barrington, Illinois.

CLEANED SAFELY WITH PFIZER CITRIC ACID

STAINLESS STEEL BOILERS, HEAT EXCHANGERS, ATOMIC INSTALLATIONS, CHEMICAL PROCESSING EQUIPMENT CLEANED SAFELY, EFFICIENTLY WITH PFIZER CITRIC ACID

● Industry experience proves that citric acid eliminates chloride stress corrosion problems — provides effective descaling — permits easier, more efficient after-rinsing.

Discuss with your chemical cleaning service company these advantages of Pfizer Citric Acid in stainless steel cleaning solutions:

1 Citric acid is highly efficient in removing imbedded metal and oxide films from stainless steel.

2 Citric acid's excellent sequestering ability prevents reprecipitation of dissolved scale.

3 Citric acid cleaning eliminates the problem of chloride stress corrosion.

4 Citric acid can be effectively inhibited without losing its cleaning or sequestering ability.

5 Citric acid is sold as a dry, 100% acid — meaning savings in storage and handling.

6 Citric acid is water soluble, easy to handle, and non-toxic.

Let us send you further information, cost and obligation-free!

I want to learn more about the use of Pfizer Citric Acid for cleaning stainless steel equipment. Please send me Technical Bulletin 102.

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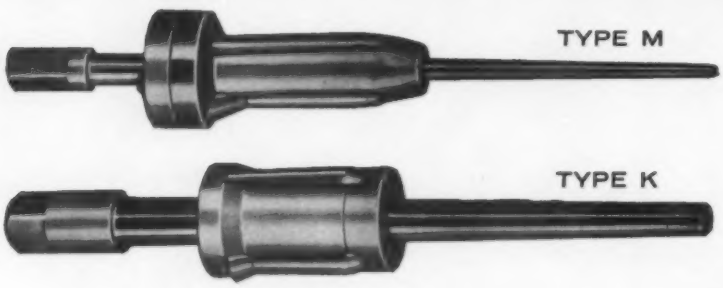
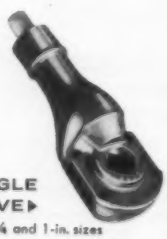
Boiler Tube Expanders
for tubes 3/4 in. I.D. and up



This 16-page bulletin describes general types of Elliott boiler tube expanders for fast, efficient tube rolling jobs. It also gives dimensions, prices and other descriptive data and shows various drum, header and short series mandrels which are used with Elliott boiler tube expanders. Drum mandrels are seen with Type M and Type K above.

Accessories available to adapt Elliott boiler tube expanders to various tube rolling applications include universal joints and extension shafts, sockets, gear drives, etc. A heavy-duty, right-angle gear drive utilizes roller bearings to minimize friction, cutting down power losses.



Write the Elliott Company, Lagonda Operation, Springfield, Ohio, *today*, for your copy of Bulletin Y-46-A.

Y1-7

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Around the power circuit

Continued from page 6

DIESEL PEAKING generating set for use in the Hawaiian Islands is being built by Fairbanks, Morse & Co. for Hilo Electric Light Co., Ltd. It will deliver 2000 kw within 90 seconds from a cold start and is a sister of six turbocharged packages of instant power installed last year for radar duty at Thule Air Force Base, Greenland, 900 miles from the North Pole.

SUBSTANTIAL AGREEMENT as to contractual arrangements for a nuclear power plant has been reached with the Dairyland Power Cooperative of La Crosse, Wisconsin, and Allis-Chalmers. Designated as La Crosse Boiling Water Reactor, the plant would incorporate a 50,000 net electrical kilowatt boiling water reactor employing forced circulation and internal steam separation. It would be completed in 1964.

MARRIAGE of chemical and electrical energies aimed at providing a new and economical heat source for industrial use is under development by Arthur D. Little, Inc.

The Combex-ADL Burner is a patented invention of Bela Karlovitz, of Combustion and Explosives Research, Inc. It can supply heat in the 3000-6000 F range for chemical and metallurgical processes.

The burner boosts the energy from ordinary combustion of a fuel-oxidant mixture by superimposing on the flame electrical energy from a low-current, high-voltage, alternating-current discharge.

Addition of electric power equal to one-half the chemical combustion power at an optimum air-fuel ratio has boosted the gas specific enthalpy (heat content) from 1100 Btu/lb to 1600 Btu/lb. Enthalpies of 1900 Btu/lb were obtained with fuel-rich flames, and still higher figures are expected.

Development work to date has used an electrical discharge from a 60-cycle a-c power supply at discharge potentials up to 2000 v and currents to 12 amp.

new engineering books

Gas & Air Compression Machinery, by Lyman F. Scheel; 338 pages, 6¼ by 9¼ in., cloth bound. Published by McGraw-Hill Book Co., 330 W. 42nd St., N.Y. 36, N.Y. Price $12.

This book covers three areas; a mathematical treatment of the static and kinematic behavior of gases; discussion of the various types of machinery used in the movement of gas, including reciprocating, turbo, rotary and ejector types; and a résumé, including economic consideration, of prime movers used for gas machinery.

Many examples are worked out, and a comprehensive set of problems for each chapter illustrate pertinent objectives. A new concept of piston compression is featured which accounts for the aerodynamic losses between the line pressures and the internal cylinder performance.

A. K. Hegeman assisted L. F. Scheel in preparing the text. The two have had many years of experience in all phases of engineering, installing, merchandising, operating and servicing gas compression machinery, and have produced a useful, convenient guide to the use of modern pneumatic machinery.

A Hole in the Bottom of the Sea, by Willard Bascom; 352 pages, 6¼ by 9½ in., cloth bound. Published by Doubleday & Company, Inc., 575 Madison Ave., New York 22, N.Y. Price $4.95.

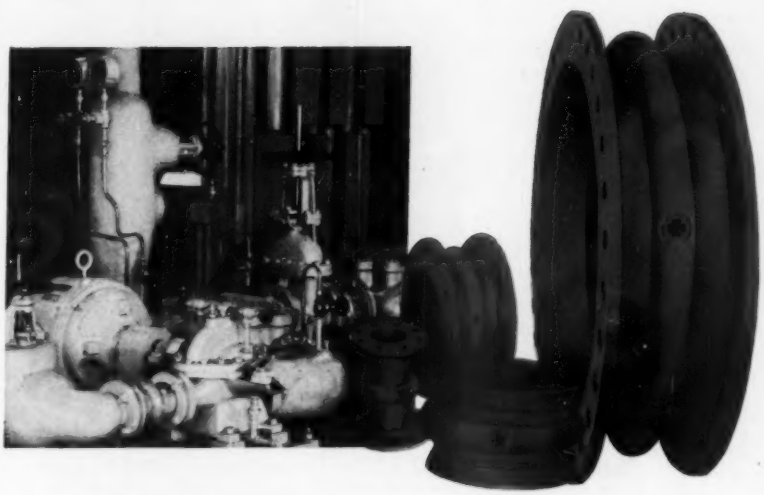
Since the Mohole has not yet been drilled, this book cannot, of course, describe the actual accomplishment of the project. But Willard Bascom, director of the Mohole Project, presents a most absorbing account of the plans and preparations. He also shows the great need for such an undertaking to determine the exact composition of the earth's mantle.

Importance of the earth sciences is clearly brought out. Since members of our solar system had a common origin, anything learned about the earth's interior is helpful to those who wish to know about the moon and Mars and the other planets and their moons.

Here is a wealth of material explaining volcanoes, earthquakes,

Save... ON INSTALLATION AND REPLACEMENT COSTS *With*

GOODALL *Rubber* EXPANSION JOINTS



Goodall Rubber Expansion Joints are flexible, durable connections for pipe lines and other equipment handling virtually all fluids and gases under pressure and vacuum, to prevent excess stresses due to expansion and contraction; to counteract vibration; and to insulate against undesirable sound. They can also be designed to overcome misalignment.

EASIER TO INSTALL—on new equipment or as replacements. Light in weight, with short face-to-face dimensions. Metal retaining rings quickly aligned and bolted. No gaskets required.

LONGER SERVICE LIFE—no embrittlement or corrosion. High resistance to abrasive wear.

STYLES, SIZES AND PRESSURES TO MEET ALL REQUIREMENTS

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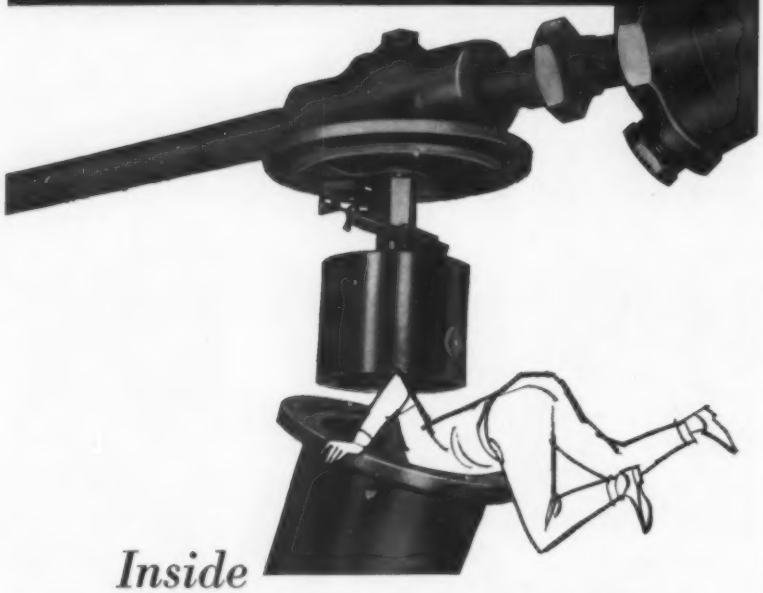
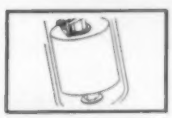
in any steam trap...
IT'S WHAT'S INSIDE THAT COUNTS



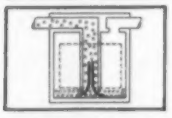
Inside
SUPER-SILVERTOPS



GUIDED BUCKET—Inverted bucket is guided on patented center tube. Results in perfect alignment—no damage to internal parts. Guarantees positive leakproof seating of valve.

NO RESTRICTED PASSAGES—Passages are short, liberal size, clean and smooth bore. Cannot clog with foreign matter. Assure full operating efficiency for trap life.

ANDERLOY VALVE AND SEAT—Eliminates erosive effect of steam. Held in place with clamp and stainless steel screws. Easily removed.



REVERSE FLOW—Bucket remains stationary and the valve open, even during heavy load periods. Stirs up sediment—keeps trap clean.

QUALITY ENGINEERING—The above features of Super-Silvertop Steam Traps are indicative of the outstanding engineering principles employed in the manufacture of all Anderson Steam Specialty products.

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BY THE MANUFACTURERS OF Hi-eF PURIFIERS

THE V. D. ANDERSON COMPANY
Division of International Basic Economy Corporation
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seismology, geology, oceanography, earth's magnetism, and many other things.

Compressed Air and Gas Handbook, third edition; 592 pages, 6 by 9 in., 323 illustrations, board binding. Published by Compressed Air and Gas Institute, 122 E. 42nd St., New York 17, N.Y. Price $8.

Completely revised, this new edition of a work which first appeared in 1947 presents the material in eight chapters: compressed air and gas in power and process service; positive displacement compressors; dynamic compressors; the compressed air system; pneumatic tools; air-operated rock drills and associated equipment; miscellaneous air-powered equipment and devices; general reference data.

About 30 experts on one phase or another of the subject contributed the latest and best engineering information to make this new handbook possible.

Managers will find the sections on air economy and centralized versus multiple-unit compressed air systems especially useful. Operators will want to refer to the articles on maintenance schedules, lubrication, starting up new compressors, and many others. The young engineer starting a career in industry will find this book helpful in getting oriented to industrial practices.

Heat Bibliography, 1959; 404 pages, 8 by 11½ in., board cover. Published by the National Engineering Laboratory (England). Available in this country through British Information Services, 45 Rockefeller Plaza, New York 20, N.Y. Price $3.70 postpaid.

This is the sixth of a series of such bibliographies, going back to 1948, and contains only material noted in the National Engineering Laboratory during 1959. Most of the references have been obtained from abstracting and bibliographic journals, and are presented in some 50 categories. Editor was D. E. Sexton, of NEL's Heat Division.

Mathematical Handbook for Scientists and Engineers, by Granino A. Korn and Theresa M. Korn; 960 pages, 6 by 9 in., cloth bound. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y. Price $20.

Each of this book's 21 chapters is arranged to permit the rapid review of a complete mathematical subject; and for a broad view of the entire field of mathematics, chapter introductions, notes and

cross-references interrelate the various topics.

Another feature of the book is the connected outline of mathematical models which are essential to exact scientific methods. By the use of concise tables and boxed groups of related formulas, and omission of all proofs, a full range of mathematical facts and data has been included in one volume. In addition, the book's detailed index makes a convenient mathematical dictionary.

Granino Korn is professor of electrical engineering at the University of Arizona; his wife, Theresa Korn, has worked as an engineer for a number of aircraft firms.

Potential Applications of Radioisotopes to the Mining, Preparation, Transportation, Storage, Handling, and Use of Coal, by Harold J. Rose, Consultant; 232 pages; 8½ by 11 in., spiral plastic binding, stiff board cover. Report by Bituminous Coal Research, Inc., 121 Meyran Ave., Pittsburgh 13, Penna.; available from the Office of Technical Services, Department of Commerce, Washington 25, D. C. Price $3.

This report, written by Dr. Harold J. Rose for Bituminous Coal Research, gives the results of a project performed by that organization for the Office of Isotopes Development, United States Atomic Energy Commission.

The report contains 110 numbered suggestions for uses of radioisotopes in the production, transportation, and use of coal. Some of these applications are now in successful use by coal producers and coal users in the United States.

The book discusses, first, general aspects of the coal industry and next goes into industrial uses of radioisotopes. Another chapter deals in detail with coal characteristics affecting radioisotope uses.

Then follow chapters on use of radioisotopes for logging of coal, for mine surveying, uses in mining, uses in coal preparation, in equipment maintenance, in coal transportation weighing and storage.

There is a detailed chapter on radioisotopes uses in coal for power generation and heat, in carbonization, gasification, and other process uses; and chapters on control of water and air pollution, use of radioisotopes in coal sampling an alysis and testing.

Data are given on sources of nuclear equipment, services, and radioisotopes; and references are given on USAEC technical information sources, plus 360 other references.

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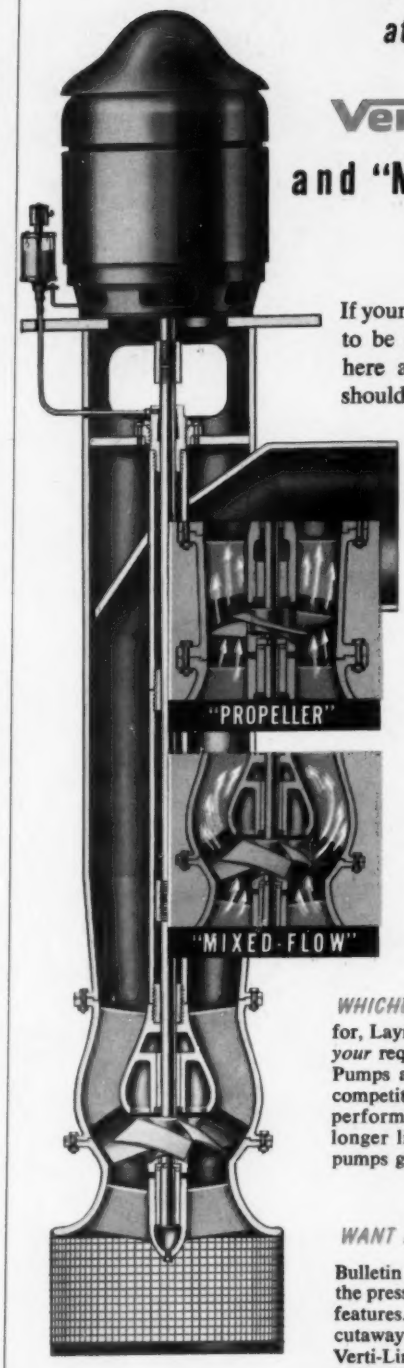

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are similar in overall design to "Propeller" Pumps except that the impeller combines the straight-lift characteristics of the "Propeller" Pump with the centrifugal force of the "Turbine" Pump.

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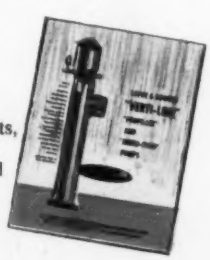
Bulletin #1400, just off the press, gives design features, performance facts, cutaway views, etc., on Verti-Line "Propeller" and "Mixed- Flow" Pumps. Write for your free copy today!



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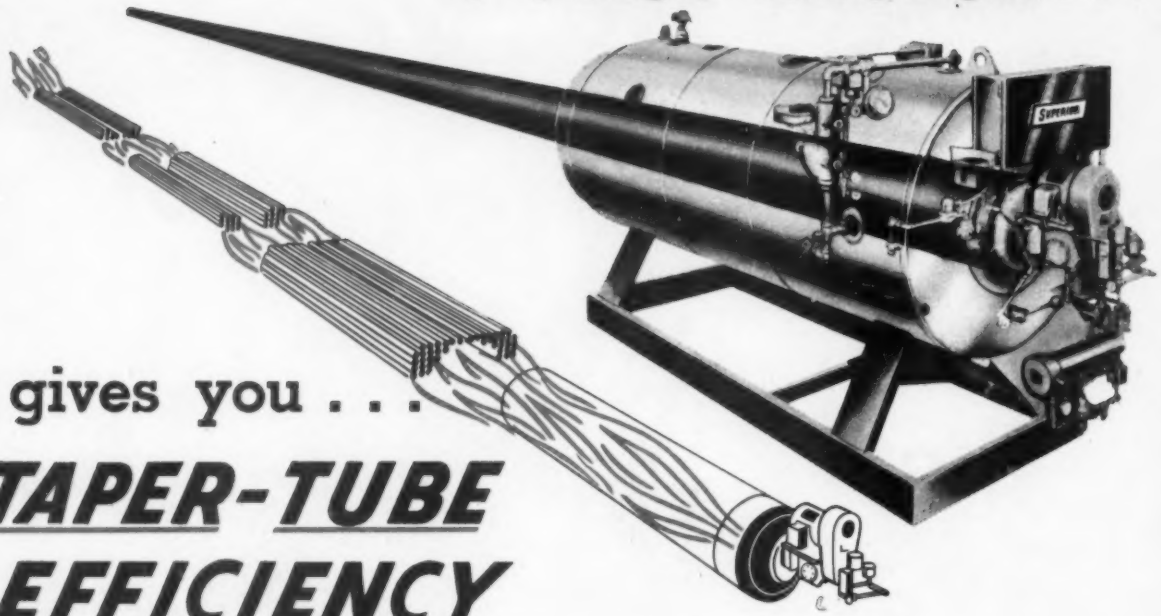
HOW SUPERIOR'S 4-PASS DESIGN...



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TAPER-TUBE EFFICIENCY

The long-lived efficiency of Superior Packaged Boilers results from fundamentals of design which are basically sound. Superior's 4-pass, down-draft design provides a minimum of 5 sq. ft. of heating surface for each unit of horsepower rating; and every inch of that heating surface is effective.

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Theoretically (from the standpoint of heat transfer alone) the fire passes of a perfectly designed fire tube boiler would resemble a long, very gradually tapered cone surrounded by water. The large end would be sized in ratio to the volume and speed of the combustion gases so that the gases would be crowded into the tube and thus "scrub" the walls of the tube, forcing contact between fire and tube surface. As the gases give up their heat to the surrounding water (by transfer through the tube) the gases shrink in volume. The gradual taper of the tube compensates for this shrinkage, maintaining the scrubbing action which promotes efficient heat transfer.

Such a fire tube is impractical; but Superior's 4-pass design achieves the same effect. Its 4 passes are so designed that each successive pass has a lesser number of tubes (and hence a smaller area in cross section) for the passage of combustion gases. This is, in effect, taper-tube performance which results in the maximum practical efficiency of heat transfer . . . performance which makes it possible for Superior to guarantee more than 80% thermal efficiency under field operating conditions.

Superior Packaged Boilers are completely factory assembled, backed by undivided responsibility. Burn gas or oil, or both. Sizes from 20 to 600 b.h.p. for pressures up 250 p.s.i. or for hot water.

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for STEAM or HOT WATER

SUPERIOR COMBUSTION INDUSTRIES INC.

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SUPERIOR PACKAGED BOILERS ®

For more data circle 544 on Post Card

Current Catalogs

continued from page 32

AD-131. Recommendations for a variety of services are given along with lengths and weights. Garlock Inc.

154 Rubber Sheet Packing — Construction details and recommended applications of natural and synthetic rubber sheet packings are covered in Bulletin PK-170A by Johns-Manville. Covers general purpose sheet, diaphragm sheet, Neoprene sheet and Nitrile sheet styles.

155 Leather Packings — Hydraulic, pneumatic, packings in a variety of sizes and shapes, including U, cup, V, flange, gaskets and washers, are described by Garlock Inc. in 12-pp Form AD-186. Complete tannage, impregnation information, design data, installation procedures, allowable clearances and ordering information covered.

156 Molded Packing—Catalog MP-361, 8-pp, by Greene, Tweed & Co., describes packings for maintenance of presses, pumps, compressors, and hydraulic and pneumatic equipment, providing selection aids for each application. Tables list composition of packings for use with various fluids and temperatures, recommended types for most common machinery, and necessary ordering information.

157 Spiral-Wound Gaskets—Revised 20-pp Folder AD-176 of Garlock, Inc., gives information on Guardian paper thin gaskets and high temperature gaskets made with ceramic filler material. Text and illustrations cover construction, specifications, flange face finish, bolting data, metal temperature range and styles.

158 Hydraulic Seal—Characteristics and advantages of SCN Rings by Bestobell Inc., consisting of flexible oil-resisting synthetic rubber sealing element, bonded to two concentric laminated fabric backing rings, are outlined in 12-pp Bulletin RC28/6102.

Other Equipment

159 Piston Rings—In addition to a simplified pricing schedule, 12-pp Catalog 661 by Piston Products, Inc. includes application data on various types of rings and cylinder liners for large bore diesel and gas engines.

160 Air, Hydraulic Cylinders — Information on selecting air and hydraulic cylinders by size, thrust, stroke, mounting, etc. is presented in 32-pp Bulletin AJH-104S by Miller Fluid Power Div., Flick-Reedy Corp. Also includes torque tables, charts on column strength, rod deflections, accelleration, safety factors and other selection data.

161 Boom Towers — Strato-Towers with safety fiberglass booms for work-

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ers on high voltage lines, wires, maintenance, tree trimming and other aerial operations are featured in 16-pp Form ST-6101 by Young Spring & Wire Corp. Charts cover heights and working capacities of models for every type of application.

162 **Insulating Fire Brick**—Properties and advantages of two insulating fire bricks for effective heat control in prepared atmospheres are detailed in Bulletin IN-294A by Johns-Manville.

163 **Compressed Air Filter** — Operating principles of a compressed air filter for removing dirt, oil and water are explained in 8-pp Catalog 6000 of King Engineering Corp. Cutaway view, specifications and detailed mounting dimensions are included.

164 **Flame Spray Applications** — Brief reports on flame spraying applications in electric power generation stations are presented by Metco Inc. in 9-pp data bulletin. Covers use in boiler feed pump casings, furnace parts, pump sleeves, circulating water pumps, valve rods, piston rods, stoker shafts, other equipment.

165 **Descaling of Boilers** — Advantages of controlled chemical descaling of boilers are outlined in Service Bulletin 40B by Oakite Products, Inc. Outlines materials, procedure and safety precautions.

166 **Concrete, Mortar Guide**—Publication X-6a, The Master Builders Co., covers job requirements and conditions, concrete floors, concrete in plastic and hardened state, curing and surface-after treatments considered when specifying concrete and mortar.

167 **Formed Wire Products** — Detailed selection data and specifications for Superformed wire products, including armor rods, lineguards, patch rods, holding and splicing grips are presented in ring-bound Catalog EP-8 by The Fanner Mfg. Co. Advantages for high tension lines and distribution systems are detailed along with application methods.

168 **Teflon-core Hose Assemblies** — Anaconda Type T4 hose and reusable fittings that can be made into assemblies with hand tools are described by Anaconda Metal Hose, Div. in Bulletin TC-46R. Gives construction, properties, engineering data, instructions.

169 **Plastic Oxidation Media** — Applications of Dow Chemical Co.'s plastic biological oxidation media in aerobic waste treatment systems are described in this 28-pp technical bulletin. Physical and chemical properties, performance data and details on oxidation towers included.

170 **Why MV Lamps**—Facts about life and maintenance, lamp construction and a chart on lumen output of Lifeguard Mercury Vapor lamps are contained in this 8-pp bulletin by Westinghouse Electric Corp.

Why Every Steam Heated Unit Needs its Own Steam Trap

. . . the theory, practice and proof of "unit trapping" for top temperatures

Using an individual trap for each steam heated unit, including each separate coil, chest or chamber of a machine—pays off for the user. Here are just two examples:

1. On a creamery dryer

Drainage Method	*Air Temperature*
Restricted Blow-thru	250°
Group trapping (1 trap for 8 coils)	225°
Armstrong Unit Trapping (8 traps—1 for each coil)	**309°**

2. On a platen press

Drainage Method	*Processing Time*
Restricted Blow-thru	50 minutes
Group Trapping	35 minutes
Armstrong Unit Trapping	**25 minutes**

Why Unit Trapping Works Best

It is reasonable to assume that no two steam heated units will have *identical* condensing rates. Even the slightest difference in rate will cause a difference in steam pressure drops through the units. Here's where the trouble starts. Condensate from each unit may flow to the trap. But, what about air and other non-condensibles in the system? A difference in pressure drops too small to be indicated by an ordinary pressure gauge will permit backflow of steam from the higher pressure units to the lower pressure units. This backflow of steam may even impede flow of condensate from the lower pressure unit to the trap . . . and it will definitely impede or block off flow of air to the trap. The result is sluggish heating, reduced temperatures, reduced output, fuel waste and increased possibility of corrosion. Figures 1, 2 and 3 diagram the action.

Unit Trapping Not Costly

No engineer wants any more mechanical devices in his plant than are absolutely necessary. But, the moderate additional cost of using two or more small traps, instead of one big one, is saved over and over again in improved efficiency.

If the traps are Armstrong, maintenance is no problem. And users frequently tell us that Armstrong traps outlast others two and three to one.

Steam traps usually represent a fraction of 1% of the cost of the equipment they drain. Does it make good sense to lose 10% or more of equipment capacity to save a few dollars on traps?

Why not test Armstrong unit trapping in your plant. If you are not completely satisfied with the results you can return the traps for a full refund of the purchase price. There is little to lose—lots to gain. Call your local Armstrong Factory Representative or Distributor, or write **Armstrong Machine Works, 8106 Maple St., Three Rivers, Mich.**

ASK FOR the 44-page Steam Trap Book and reprint of article on Unit Trapping.

8015T

How Different Condensing Rates Can Slow Production

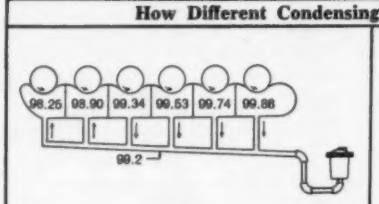


Fig. 1 This is a 6-roll ironer shortly after it has begun operating on 100 psi steam. When cold, wet material passes over chest 1, steam condensing rate is high and pressure drops accordingly. The pressure drop in chest 2 will not be as great, and so on down the machine as the material becomes progressively hotter and drier. Average pressure in the chests then is 99.27 lbs., and drain header pressure is slightly less, about 99.2 lbs. Under these conditions, steam from drain header enters chests 1 and 2 (as indicated by arrows at side of drain lines) because of pressure difference. Though condensate from chests drains by gravity, air can't leave chests countercurrent to incoming steam. Fig. 2 shows what happens next.

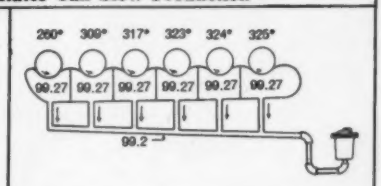


Fig. 2 This is the same 6-roll ironer after it has been operating a while. Air has accumulated in chests 1 and 2, reducing condensing rate and decreasing pressure drop. This process repeats itself down the line until pressures are as shown—that is, enough air will accumulate in each chest so that condensing rates and pressure drops of all chests will be about equal. The net result is shown in chest temperatures which are actual pyrometer readings taken on a 6-roll ironer, drained by a master trap, in a Chicago laundry. The laundry was making 337.9°F steam, but getting an average of only 309.6°F from the ironing surfaces, necessitating slow operation and frequent reruns. Then they tried Armstrong unit trapping—see Fig 3.

How Unit Trapping Prevents Trouble

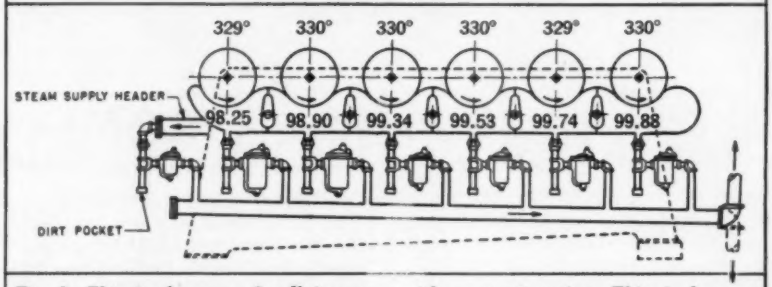


Fig. 3 This is the same 6-roll ironer, now unit trapped. Temperatures shown are also actual pyrometer readings—the average of 329.6°F is 20° higher than with group trapping. This is because air is continually removed from each chest into the drain header, and cannot get back into any chest.

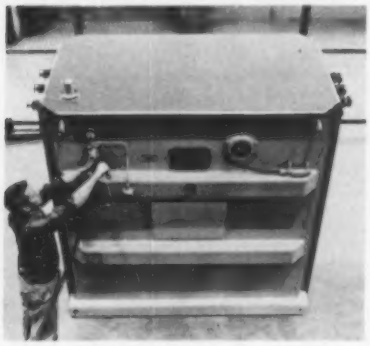
ARMSTRONG STEAM TRAPS

For more data circle 545 on Post Card

Equipment News

1—Gas filled transformer offers high impulse levels

Using C_3F_8 (perfluoropropane) gas as an insulating/cooling medium, General Electric Co.'s sealed, dry-type transformer in ratings 300 kva and above, 15 kv and below, offers higher impulse



levels, lighter weight, and smaller dimension than former nitrogen-filled units. Full wave impulse levels are reported to be comparable with liquid-filled types. Basic impulse level of the 15 kv gas-filled unit is 95 kv, compared with 50 kv for similar nitrogen-filled unit. An over/under pressure device is standard and can be connected to remote indicating devices. Units are designed for application on conventional transformers, or as transforming section in unit substation combinations.

Reader Service Cards on pages 97-98 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

3—Miniature TV camera scans interior of 3-in. pipe

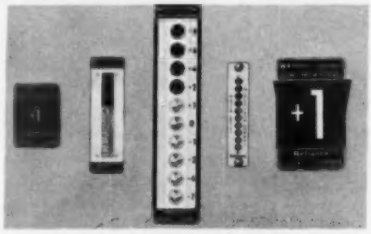
The Minicamera — 9 in. long and less than 3 in. diam.—is introduced by Fairbanks, Morse & Co. Designed for use wherever space is restricted, the camera will operate without protection in environments where there is noise or vibration. Essential components are placed in the camera itself while the others are housed in the camera control unit which is separate from the camera and can be placed at a distance.

4 — Rust and scale remover cleans stainless steel

Introduced by Berman Chemical Co., Bull Frog Scale Off No. 104 comes in dry powder form and is claimed safe and effective in cleaning of compressor jackets, condensers, steam boilers, heat exchangers, ion exchange resin beds. It is available in 6-lb tins, and 25 to 400-lb drums.

5 — Electric operated water level indicating system

No pressure connections or compensating devices are used by the Electro Eye-Hye, a system that detects water level with electrodes in a direct-to-



drum water column. It is recommended by the manufacturer, Reliance Gauge Column Co., for pressures to 3000 psi steam, 5000 psi cold. All-electric connections permit placement of single or repeater indicators at any distance. Five indicators are available, three are ten-light units, two are digital readouts, as illustrated.

6 — Urethane seals, packings have high tensile strength

Urethane hydraulic seals and packings, introduced by Disogrin Industries, have a tensile strength of over 5000 psi at break, enabling them to withstand pressures of 3000 to 10,000 psi and higher without back-up rings. Temperatures

range from —40 to 225 F. The chamfered sealing lip, a key design feature, offers leak-proof sealing at low pressures and simple assembly of seal bearing components without special tools. Seals are compatible with most hydraulic fluids and offer high abrasion, tear and wear resistance. The urethane material has high resilience, 550 per cent elongation at break, high modulus and low compression set. Available in U-cups, O-rings, cup and flange packings, rod wipers and washers.

7—Remote alarm monitor works on microwave, UHF, VHF

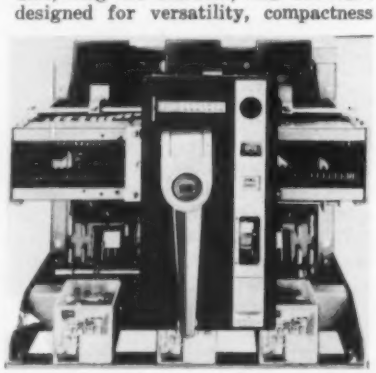
The Alertra Model 901, a solid state low cost remote alarm monitor manufactured by CompuDyne Corp., samples and encodes any number of data points and keys a single channel of any transmission medium. At the receiver, the signal is decoded and displayed. Operation is continuous. The construction is plug-in type and compact, 17 points being contained in a 3½-by-5⅞-by-

2—Low voltage power breakers meet modern requirements

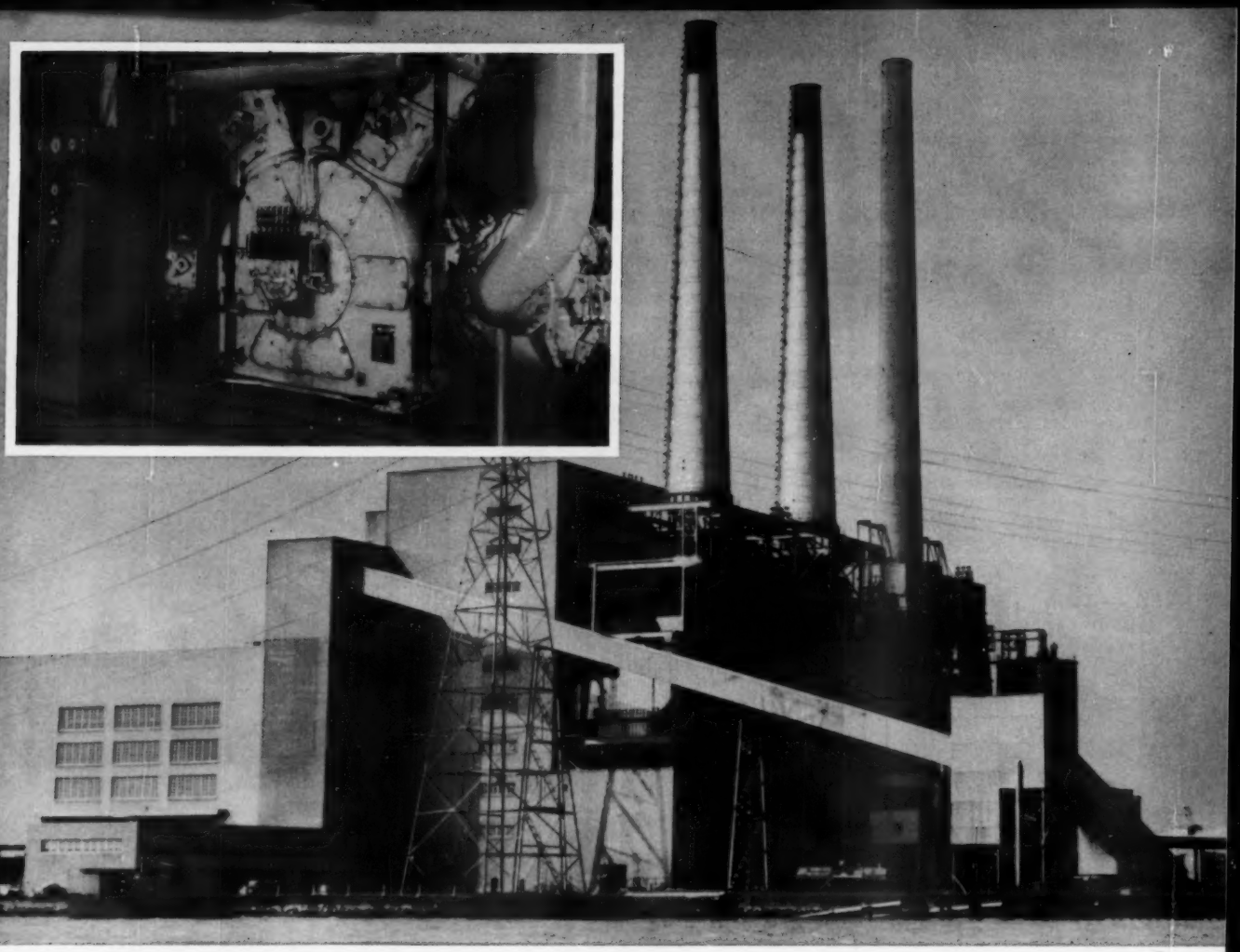
Important benefits in cost, safety and flexibility of low voltage electrical systems are announced for the FP (future planned) line of power circuit breakers introduced by Federal Pacific Electric Co. Higher interrupting capacities and continuous-current rating of the line offer advantages of fully-rated distribution systems at cascade-system prices.

The line is divided into two groups. FP 50 series consists of three increased frame-size breakers based on continuous current ratings of 400, 800 and 2000 amp with 50,000-amp asymmetrical interrupting capacity at 600 v a-c. The FP-100 series offers two frame sizes with 100,000-amp asymmetrical interrupting capacity in continuous current ratings of 3000 and 4000 amp at 600 v. Prices of the uprated FP line will be comparable to those of previous lower-rated breakers.

Besides advantages of fully rated systems without price penalty, increases in interrupting capacity afford optimum continuity of service and safety to personnel and equipment, manufacturer states. Other features announced include an improved, fast-acting stored energy mechanism, adjustable trip unit, long-life contacts, and enclosure designed for versatility, compactness



and accessibility. Photo shows a 2000-amp frame size breaker in the FP line. It replaces the 1600-amp frame size of previous units without increase in dimension or cost. Bulletin FP-1-6010 gives full data.



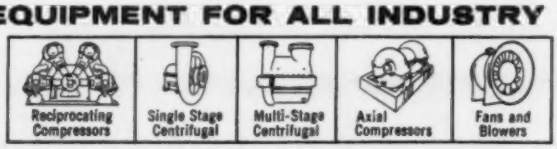
MODERN JOY WH-234 COMPRESSOR SUPPLIES 300 LB. SOOT BLOWING AIR AT DETROIT EDISON'S RIVER ROUGE PLANT

A Joy WH-234 Semi-radial Compressor was installed at the River Rouge Plant to provide additional 300 pound soot blowing air when a huge 321,500 KW turbine-generator was added in 1957. The new unit gave the River Rouge Plant a total installed capacity of 841,500 KW, making it one of the largest power plants in the country.

Joy's modern semi-radial construction provides a compressor which is both rugged and compact. Floor space requirements are less than for any other type of compressor of comparable capacity, yet valves are easily accessible for inspection and maintenance. Truncated piston design gives high compressor efficiency by reducing head clearance to a minimum—cutting re-expansion loss. Like all Joy compressors, the WH-234 features replaceable cylinder liners and crosshead guides, force-feed lubrication and rugged construction throughout for long, maintenance-free service life.

Consult your Joy representative for complete details on Joy high pressure compressors for soot blowing, or write for Bulletin 2554-56C.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

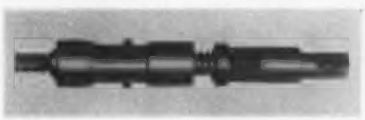
For more data circle 546 on Post Card

6¼-in. package; 115 v ac or 12 v dc operation are standard. At the transmitter, switch closures or excessive voltage levels are detected and coded for transmission by PDM/NRZ Code. This

coded information is keyed over the transmission medium. At the receiver the code is converted to yes/no information and is displayed as alarm conditions at panel board. Facilities for line and circuit test are included. Contacts for print out or control sequencing can be had. Bulletin 901 gives data.

8 — Tube sheet cutting tool minimizes tube rolling failures

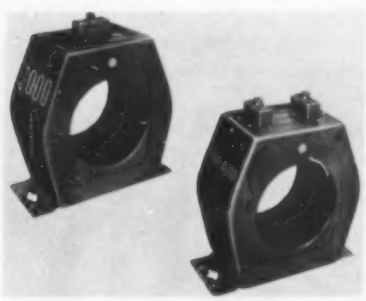
This serrating tool, by The Airetool Mfg. Co., aids installation of tubes in heat exchangers and condenser tube sheets by cutting grooves in the tube



sheet holes to assure leakproof tube joints and help eliminate failures when rolling or expanding tubes into tube sheets. It can be driven by pneumatic or electric motor. Three drives are available, including Morse taper, square or three-jawed chuck. Company's 600-D pneumatic 335 rpm motor is recommended for use with this tool for steel and brass tube sheets

9 — Current transformer with high overload capacity

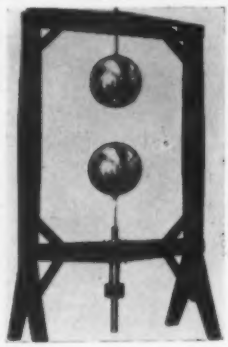
Designed for high-current metering and relaying on low-voltage systems, Type EMC Current Transformer, of Westinghouse Electric Corp., is announced as a 600-v window-type unit in current ratings to 4000 amp with up to 100



per cent more overload capacity. It has a mounting hole in each corner for versatile mounting of vertical or horizontal bus. Units are available with three or four terminals. The primary opening, 5½-in. diam, can accept a 4-in. square bus or multiple cables.

10—Sphere gaps measure a-c d-c and impulse voltage

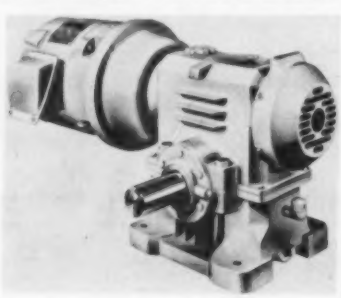
Introduced by General Electric Co. is a full line of high voltage sphere gaps for measuring a-c, d-c and impulse voltage in dielectric materials and insulated apparatus. They are also suited for use as a protective device to prevent excessively high voltage from being applied to the test specimen, to



calibrate testing equipment and to check wave form of applied test voltages. The sphere gaps come in seven diameters from 2.54 to 100 cm, at spark-over ratings of 8.5 to 1338 v in bench- or floor-mounted units. Each assembly features a pair of polished, adjustable metal spheres mounted on an insulated framework. Gaps can be adjusted and have a separate current-limiting, non-inductive resistor assembly. According to manufacturer, the units feature consistent spark-over voltages, have non-inductive resistors to provide resistance at least 1 ohm per volt of test voltage.

11—Speed reducers with involute helicoid thread form

Motorized worm gear speed reducers with high-capacity Delroyd involute helicoid thread form, designed to facilitate installation and interchange of motors are available from De Laval-Holroyd, Inc. with any standard NEMA Type D flange motor. They come in eight sizes for motors from 1 to 20 hp, center distances from 2½ to 8 in. and speed ratios of 5:1 to 70:1 and higher. Single or double-extended gear



shafts are available. Maximum load capacity within a compact gear box, higher efficiency and quiet operation are prime advantages of involute helicoid thread form.

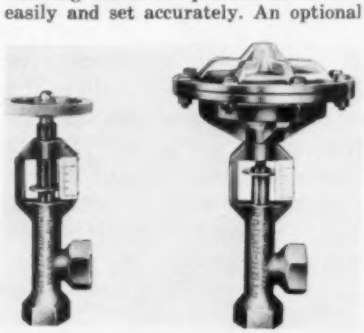
12 — Data processing system with alphanumeric capability

Burroughs Corp. has integrated its Series E computer with a 10-total typewriter accounting machine to provide a compact, desk-size electronic business data processing system with alphanumeric capability, eliminating the need for additional units to write descriptive information on accounting forms. Its simplified external pinboard command process keeps programmer training

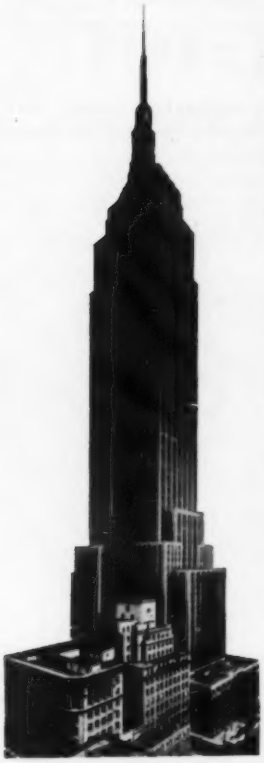
down to a few hours, it is claimed. Extending the versatility of the computer is "Tri-plex input" which allows data to be fed into the system by three optional methods, using two punched-paper tape readers and a punch card unit, three tape units, or two punch-card units. Output can be by a tape or card punching device or both. A remanufactured system sells for $29,000, or rents for $1,200 monthly.

13—Indicator valve shows orifice position at-a-glance

Designed for safety and efficiency, the indicator valve, by Flow Systems, Inc., has its indicator located on the outside, allowing the orifice position to be seen easily and set accurately. An optional



locking handle is available. Its outside-thread location prevents corrosion. Sizes range to 4 in., with a variety of standard tips and seats for flow requirements, including the Micro-Flo for ultra-fine flow. Panel-mounting style



How Empire State Building and American Airlines solved vital fire protection problems with EVERLASTING VALVES

102 stories, 1,472 feet high, 16,000 tenants and 35,000 visitors sum up the fire protection problem of the Empire State Building. An in-building fire protection system is necessary to an unfailing water supply.

American Airlines loading bridge, shown below, gives passengers positive protection against fire with a unique deluge system.

Both these fire protection systems depend on Everlasting Pendulum Stop Valves, which have been installed in thousands of critical fire protection systems over the past 35 years.

For complete information on the unique American Airlines and Empire State Building systems, write for bulletins F. They include an editorial description of both these installations and a bulletin describing Everlasting's positive action pendulum stop valves.

Everlasting also makes a line of quick-opening valves for general service, boiler blow-off, and handling viscous materials, as well as a line of cylinder-operated valves. Bulletins on all these valves are available. **Everlasting Valve Company, 47 Fisk Street, Jersey City 5, New Jersey.**

EV 410

formula for better tube maintenance

Airetool power + accuracy

Efficient power depends on efficient tubular equipment . . . properly maintained. Proper maintenance depends on Airetool because Airetool makes the right pneumatic tool for every job.

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Airetrol automatic expansion control; one man rolls twelve ½" to 1½" tubes a minute . . . to .001" accuracy. Electrically operated systems for fast, accurate rolling of larger tubes.

CONDENSER CLEANERS

Lightweight cleaners for tubes up to 1" O.D. Outside mounted motors for larger tubes . . . all with built-in flushing systems.

BOILER TUBE CLEANERS

Air-powered motors and cleaner heads for high-speed internal cleaning of tubes.

NEW
AIR-POWERED
SERRATING TOOL
Grooves tube sheet holes so tubes can be locked in position as they are rolled.
NEW
PNEUMATIC
LIGHTWEIGHT
SCALER
For scaling, peening, beading and star drilling. Fast rust, weld splatter and paint removal. 11" long, weight — 4 pounds. Operator accurately controls blows per minute from a few up to 4600.

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AIRETOOL
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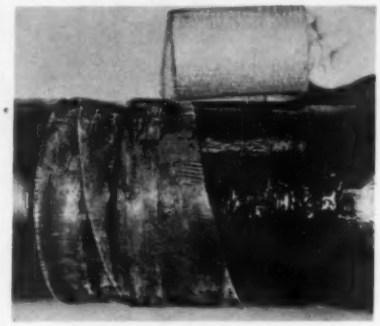
More than 30 years' experience in pneumatic tools

For more data circle 548 on Post Card

may be chosen. Comes in standard materials, stainless steel, carbon steel with stainless-steel trim, and bronze. Pressure ratings to 10,000 psi.

14 — Mastic coating and wrap protects piping underground

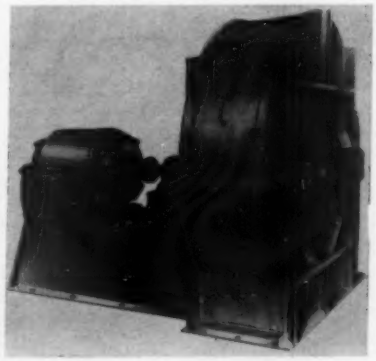
Rip-Coat is a mastic colloidal resin resistant to moisture, weathering, acids, alkalis and electrolysis, introduced by Ric-wiL, Inc. for making underground piping connections. It is



claimed unaffected by temperatures from sub-zero to 250 F, and to withstand severe distortion and bending. Rip-Coat is brushed on over the welded conduit joint and a glass-wrap material applied over it. A final coating of Rip-Coat is then applied over the wrap to complete the closure.

15 — Industrial centrifugal fan features airfoil blading

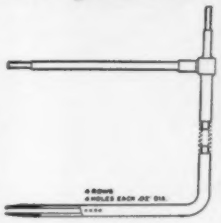
Heavy duty fans in the Series 8500 of Westinghouse Electric Corp. are tailored to bring efficiency and quiet performance of airfoil blading to direct-connected motor speeds. They are suited for such applications as combustion air for steel mill furnaces, packaged steam boilers, exhaust from aluminum pot lines etc. With capacities from 15,000 to 450,000 cfm, the units come in five a-c direct-connected motor speeds from 1800 to 750 rpm. Within this



range are 10 sizes of AMCA Class III-type fans with 30- to 81-in. diam wheels, and 14 sizes of Class IV-type fans, 30- to 109-in. wheels. The fans handle air from —20 to 800 F. Bear-

The ELLISON Line Of PITOT TUBES Is The Most Complete!

Angle Types (at right), Straight Stem Types, in brass and in stainless steel (for temperatures to 1000° F.). Dust Type Pitot Tubes (at left). Water Cooled Pitot Tubes for very high temperature use. Water Flow Pitot Tubes. Velocity Gages supplied if desired. Pitot Tube Sets in carrying cases. Special Pitot Tubes to order.



Send for Pitot Tube Bulletin.

SINCE 1896

ELLISON DRAFT GAGE CO., INC.

550 W. MONROE STREET, CHICAGO 6, ILLINOIS

Draft Gages, Bell and Diafram—Inclined Draft Gages—Portable Inclined Tube Gages—Vertical Tube Gages, Oil, Heavy Liquid, Mercury, Single and Multi-tube—U-gages, Stationary and Portable—Air Filter Gages, Complete Line—Pitot Tubes—U-Path Steam Calorimeters—Portable Gas Analyzers, Orsat Type—Alarm Systems—Orifice Flanges and Plates—Flow Tube Meters—Condensate Traps.

For more data circle 549 on Post Card

The easiest—and quickest—way to order bulletins and catalogs described in this magazine is to use the postage-free Reader Service Cards on pages 97-98.

All you need to do is circle the item numbers of those you want. Then fill in your name, job title, company name and address — and mail the card.

You may also use the Reader Service Cards to request information on products described, or literature mentioned in the ads — just circle the number below the ad.

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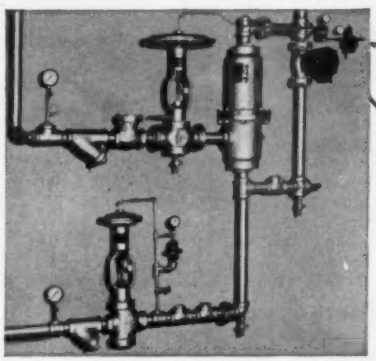
Accurate Temperatures . . .
Low Cost . . . Any Quantity from
500 to 50,000 Gallons Per Hour!



Pick STEAM INJECTION

WATER HEATERS

for high or low pressure steam

Direct contact of steam and water in the Pick patented mixing chamber produces hot water at the desired temperature, and in the required quantity, *instantly!* There's no time lag . . . no steam wasted to maintain heat in stored water . . . steam used only as hot water is drawn. Water temperature maintained within 3° plus or minus. Volume adjustable from 5% to full rated capacity. Pick heaters require no floor space . . . usually installed on wall. Whatever your hot water needs are, Pick will do it faster, more accurately and at lower cost!

FREE CATALOG — Contains complete information and specifications. Write today to Dept. S.

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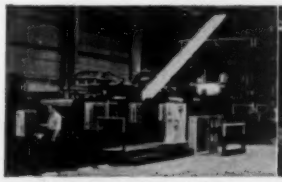
PICK Manufacturing Co.
Water Heater Division
WEST BEND, WISCONSIN

Used by America's Leading Industries:



U. S. Steel, Gary, Indiana
Continuous annealing line

Bates Mfg. Co., Lewiston, Maine
Finishing Process of Bedspreads

General Aniline & Film Corp.
Linden, New Jersey
Filter press washing

Gerber Products Co.
Fremont, Michigan
Sterilizing, washing & processing

For more data circle 550 on Post Card

ings are integral with fan unit; motor (or turbine) is direct-connected to fan shaft through couplings. Fans are welded, reinforced steel.

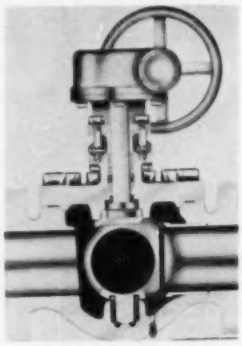
16 — Data processing system has built-in printer

With the IBM 1404 Printer for the 1401 data processing system, designed by International Business Machines Corp., accurate printing of individual cards or continuous paper forms as direct output from a computer can be obtained, providing significant time savings in many operations. When it is used with a 1401 magnetic type system the

printing and punching of cards can be performed in the same run. Or, in an alternative procedure, a bill register can be printed on the continuous forms feed of the 1404 at the same time as the 1402 is punching the cards. Printing of the pre-punched cards is then done during a second run.

17—Ball valve with non-scoring metal-to-metal seal

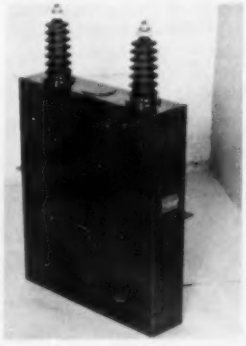
In the Ludeman Rotoflo valve—offered by General Kinetics Corp.—the cam action of the stem lifts the ball away from the seat before it is turned, eliminating the sliding friction that wears and scores the seat of other ball valves. It permits the use of hard metal-to-



metal seating surfaces which assure tight shut-off and permit the valve to be used at high temperatures and under radio-active conditions that would destroy plastic seat rings. It is available with manual, pneumatic, electric or hydraulic operators.

18—Compact capacitors produce more kvar per pound

According to General Electric Co., Unifilm 100 Capacitor, weighing only 132 lb and occupying 2050 cu in., produces more kvar per pound and cubic inch than other 100-kvar capacitors presently available. The new size and weight



reductions will enable utilities to install more kvar per pole and substation. Installed in substation banks, the "100" units take up as little as 61 per cent of space required with 50-kvar units. Since up to 30 capacitors can be installed in one rack, 50 per cent more kvar can be handled in one piece than was possible with 50-kvar units. Equipments also have only half as many connections, bushings and fuses subject to periodic inspection. A uniform film of liquid

. . . in the chemical treatment of your WATER—STEAM—FUEL. For over 70 years Western's special formulas and individual technical service have been controlling scale, corrosion, foaming, algae, sludge, soot, and related operating problems. Ask for the brochures that apply to your own needs.

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Mercury Actuated Dial Thermometers now in three types to suit any requirements

PATENTED
FULL 4½" DIAL FACE. Stem can be placed at any angle and case can be rotated to any readable position.
1 RIGID STEM DIAL THERMOMETER tapered bulb, interchangeable with standard industrial thermometer separable socket. (As illustrated above.)
2 WALL MOUNTED DIAL THERMOMETER with flexible connecting armor. Case adjustable to easy reading position.
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ALL THREE TYPES HAVE A FULL 4½" DIAL FACE.

■ **for accuracy:** Mercury actuated . . . Compensated by Invar. Guaranteed Accurate 1 scale division. ■ **for angularity:** Can be adjusted to most readable position at any angle desired. ■ **for readability:** Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position. ■ **for interchangeability:** Also specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

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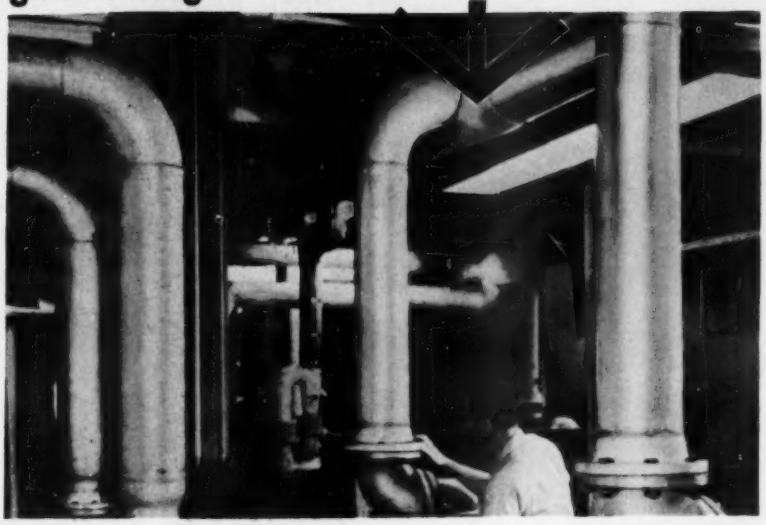
from ALCOA

good designs made better with aluminum



All-aluminum cooling system reduces danger of water contamination in Brookhaven's new Synchrotron

More than one mile of aluminum piping and some 2,600 FLOWLINE aluminum fittings comprise the magnet cooling system at Brookhaven National Laboratory's new Alternating Gradient Synchrotron. High-purity water at 65°F is circulated through an aluminum piping system to cool electromagnets arranged in a one-half mile long circular ring; the water is then returned to heat exchangers. Because the conductivity of the water must be kept below 11 micromhos, aluminum was selected for its superior resistance to corrosion. View of pump room above shows sections of aluminum piping; FLOWLINE tees, elbows, and reducers, made with ALCOA® Aluminum by Flowline Corp., New Castle, Pa. For more information about aluminum's applications and versatility, please send the coupon.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

Aluminum Company of America, 828-J Alcoa Building, Pittsburgh 19, Pa.
Please send me the following literature covering Alcoa Aluminum for tubular products and other uses in the process industries:

- ☐ 34-10197 Aluminum Pipe and Fittings
- ☐ 34-10418 Alcoa Unitrace: Combines Piping and Tracing in One Unit
- ☐ 68-10460 Process Industries Applications of Alcoa Aluminum
- ☐ 88-11453 Solving Refinery Corrosion Problems with Aluminum

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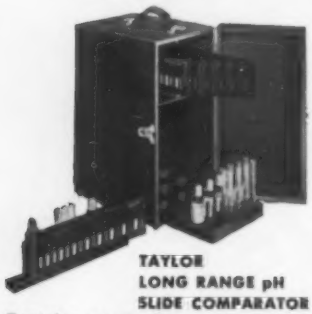
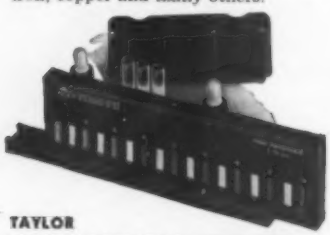
WHAT'S IDENTICAL ABOUT THESE TAYLOR COMPARATORS?

ALL GIVE YOU FAST, EASY, ACCURATE TESTS to aid power plant operations



TAYLOR LONG RANGE pH SLIDE COMPARATOR
Contains any 7 color standard slides in the 3 to 9 pH range. Range can be increased with additional standards.

TAYLOR WATER ANALYZER
For accurate tests of pH, condensate silica, hydrazine, morpholine, total iron, copper and many others.



TAYLOR HIGH PHOSPHATE COMPARATOR
For controlling internal conditioning and hot phosphate softeners.

ALL TAYLOR COMPARATORS HAVE GUARANTEED NON-FADING COLOR STANDARDS

SEE YOUR DEALER for Taylor Sets or immediate replacement of supplies.

FREE HANDBOOK, "Modern pH and Chlorine Control". Gives theory and application of pH control. Illustrates and describes full Taylor line.

W. A. TAYLOR AND CO.
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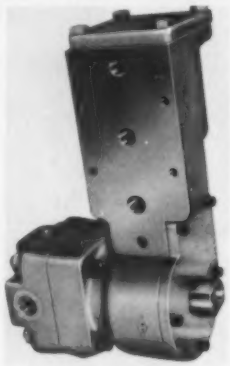
dielectric between the sheets of paper and between paper and foil in the winding results in reduction in average distance, but not minimum distance, between foils.

19—Shop air pressure operates 6000 psi valve actuator

Regular shop air pressure, 100 to 125 psi, or hydraulic pressure, will operate the Lo-torq valve actuator announced by Republic Mfg. Co. The air/oil actuator is nose-mounted to the valve, making a compact, efficient arrangement for



positive action. The cylinder is three-position, operating 45 deg each side of center, in any combination of 45 and 90 deg movements. Maximum working pressure is 500 psi. An operating valve, designed for the air/oil actuator, may be located anywhere air or oil lines can be run. Positive remote control, through use of the operating valve, permits location of the Lo-torq valve in inaccessible places. Actuators may be mounted to Lotorq B valves, having 90-deg handle turn, up to 1 in. size.

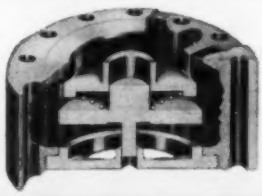
20 — Plastics-welding kit for training and maintenance

Model 15-TM is designed by Kamweld Products Co. for training of welders and for maintenance and repair of plastic-fabricated products. Kit consists of Model 14-HW Welder, aluminum welder-stand, round welding tip, 16-ft Neoprene air hose with three-wire cord, "practice" pieces, instruction manual and bulletin — in a steel carrying case. Equipment is suited for tack-welding, hand-welding and medium-speed welding of many thermo-

On the Boiler Feedwater lines in a large eastern paper mill . . .

Williams-Hager Silent Check Valves provide positive protection against surge pressures and resulting water hammer. Silent in service and rugged in construction, Williams-Hager check valves operate effectively regardless of their installation position.

Write for Bulletins: No. 654 on Valves; No. 851 on Cause, Effect and Control of Water Hammer; No. 659 on Pressure Loss Tests.



WILLIAMS • HAGER
Silent
Check Valves

The Williams Gauge Company, Inc.
143 Stanwix Street • 2 Gateway Center
Pittsburgh 22, Pa.
Our 75th Year • 1886-1961

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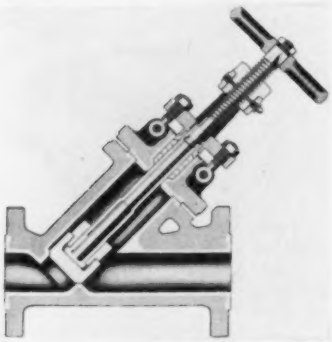
plastics such as polyproplene, polyethylene, rigid and plasticized PVC, and plasticized tank linings.

21—Plastic lined valve resists corrosive effects

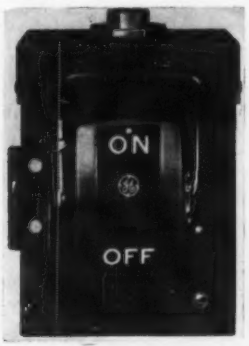
Designed to combat destructive effects when controlling flow of corrosive fluids, this Y-type metal valve introduced by The Wm. Powell Co., has all



wetted or inner parts and surfaces (inside surface of body and bonnet, stuffing box and stem) protected by heavy plastic lining. Choice of three plastic linings is determined by service for which valve is required, as well as pressure and temperature of corrosive fluid to be handled. Valves are cast carbon steel, but can be supplied in other alloys, in sizes from 1 through 3 in.

22—Safety switches, 30 to 600 amp, in raintight enclosures

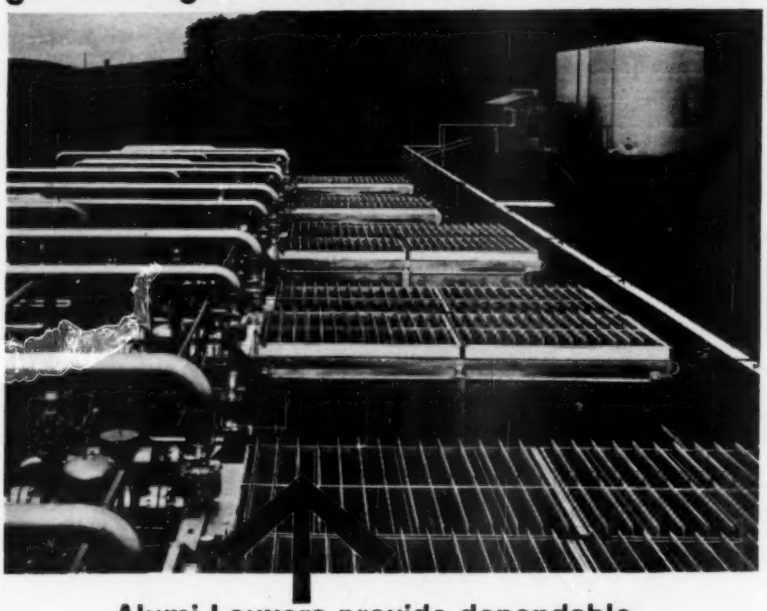
Red-handled safety switches in raintight NEMA Type 3R enclosures offer two convenience features. The first lets an installer remove the switch cover by loosening just two screws. Rugged cover supports are the second feature—they hold the front cover up, letting an electrician use both hands when



servicing the device. Both light duty (Type TG) and heavy duty (Type TH) raintight switches are available in same ratings as indoor devices: 30 through 600 amp, 240 and 600 v a-c. Products of General Electric Co., they provide the same performance and safety characteristics as company's indoor NEMA Type 1 line, including heavy duty ability to withstand 200,000

from ALCOA

good designs made better with aluminum



Alumi-Louvers provide dependable, economical ventilation at New York State Natural Gas Co.

For uninterrupted, maintenance-free performance, Mansfield Metal Fabricating Co., Mansfield, Ohio, constructs its famous *Alumi-Louvers* of Alcoa® Aluminum. A typical installation (shown) is at New York State Natural Gas Co., Tamarack, Pa. *Alumi-Louvers* require no maintenance, provide dependable, economical control of ventilation and temperature. Mansfield reports that lightweight aluminum cuts transportation and installation costs (special rigging is unnecessary). For more information about corrosion-resistant aluminum, please send the coupon.

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ALUMINUM COMPANY OF AMERICA

Aluminum Company of America, 828-JJ Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature covering Alcoa Aluminum for tubular products and other uses in the process industries.

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- ☐ 61-21088 *Aluminum Cooling Towers and Their Treatment*
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CRUSHING FACTS
from American PULVERIZER CO.

When You Figure Costs, The Best Results Come From American Coal Crushers

An independent survey of the performance of American Coal Crushers in 29 Mines and Power Plants showed these results:

Total Tonnage — 61,000,000

Average Age of Crusher — 9.5 years

Average Cost of Replacement Parts per Ton of Coal Crushed — $0.0012

There can be no better proof of the built-in quality of American Rolling Ring Coal Crushers.

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ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
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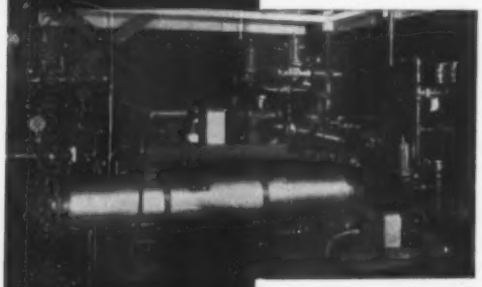
Fuel Oil Pumping and Heating Systems

For heavy bunker oil or light furnace oil...100 to 10,000 gallons per hour

Enco systems employ one, two or more pumps and heaters, interconnected so that full capacity is possible with any combination of pumps and heaters. Flexibility of design permits the use of any combination of rotary pumps, with motor or turbine drive; or piston type steam pumps. Any part may be cut out of operation for inspection or cleaning, without shutting down, where two or more pumps and heaters are included in the unit system.



Heaters are insulated and jacketed with removable heads at both ends for cleaning without breaking any piping connections or removing any tube bundles.

Full automatic oil pressure and temperature control, with relief valves for each pump and heater. Permits delivery of oil with safety, and at proper temperature and pressure for efficient burning.

Each unit is built to order and delivered ready to place on foundation and for connection to the station piping.

Write for Bulletin OB-53 describing Enco Gas and Oil Burners; and Pumping and Heating Equipment.

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NEW YORK 6, N. Y.

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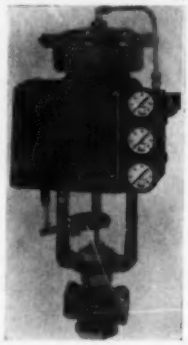
amp short circuits. Provision for interchangeable raintight conduit hubs is made in devices up to 200 amp.

23—Versatile valve positioner uses force balance principle

100N Series Positioner is announced by Taylor Instrument Companies as a rugged, compact and economical instrument having optional accessories to lend versatility to its applications It may be used as a simple controller or



as a position-indicator-transmitter in addition to its prime function of providing faster, more positive response for diaphragm actuators. Providing excellent linearity between controller output pressure and resulting valve stroke, the instrument may be used with direct- or reverse-acting response. Bulletin 98414 gives details.

24—Oil-immersed contactor for starting a-c motors

Announced by Westinghouse Electric Corp. three-pole Type K Contactor for starting and controlling a-c motors on 2300- and 4800-v systems has a continuous current-carrying capacity of 400 amp and an interrupting capacity of 50,000 kva. Contact assemblies operate submerged in oil and employ magnetic blowouts and single-break contacts Copper-tungsten contact surfaces are close to tank bottom and arranged so that arc movement, during interruption, is horizontal through the oil. This results in maximum head of oil above contacts and keeps arc below surface when heavy fault currents are interrupted. Needs only 17 gal of oil.

25—Bender works easy on installed, limited-access tube

Models 293 through 298 tube benders in six sizes to ½-in. OD, suggested for use with copper, aluminum, stainless steel and brass are announced by The

Ridge Tool Co. Marring and deformation during operation are prevented by steel forming shoes and rolls. A "stop boss" holds tubing in place. Calibration marks on the rolls are graduated in 45 deg angles.

26—Circuit breaker oil—high flash point, low viscosity

Sun Oil Co.'s improved transformer-circuit breaker oil has a 300 F flash point and a low 58 SUS/100F viscosity, giving better heat transfer, while reducing evaporation and fire hazard, and improved flowability, while facilitating heat removal. Offering excellent resistance to electrical stress, its dielectric properties and oxidation stability give minimum power loss and maximum service life. The wax-free structure eliminates solidification at lower than –50 F. Oil is available as standard without inhibitors as grade A-HT; inhibited grades are also available.

27—Vertical file holds drawings, plans and prints

Mobile Plan Rack, introduced by Plan Hold Corp., has a tubular steel frame and ball bearing casters. It can be adjusted to accommodate sheets up to

36 by 48 in. and is intended for use with 12 Type S binders for filing up to 1200 sheets. Rack weighs less than 18 lb, and occupies only 3 sq ft of floor space. Price is less than $20.

from ALCOA

good designs made better with aluminum

Griscom-Russell designs and builds record heat exchanger with 525 miles of Alcoa Aluminum coiled sheet

World's largest single-cell fin-fan unit, this air-cooled heat exchanger (cut shows cooling sections only) was installed in a major European refinery. Designed and built by Griscom-Russell Co., Massillon, Ohio, it cools heavy hydrocarbon liquid over a 300°F range. Containing 525 miles of Alcoa® Aluminum coiled sheet, the unit has a total cooling surface of 267,000 sq ft. Advantages of aluminum: high thermal conductivity, corrosion resistance and low cost. For more information, please mail the coupon.

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THE LONERGAN LINE

LITTLE THINGS MEAN A LOT

by Norman J. Smith

No, I'm not trying to revive a popular song of a few years ago. Instead, I just want to point out that that statement is true in gauges as well as love.

For example, research has shown that the tip of a Bourdon tube travels not only in a straight line, but, has a definite relationship to the angular length of the active part of the tube and its inactive section, which makes up the tip end.

The arrow shows what I mean by the tip travel.

Why is this important? For several reasons.

First of all, Lonergan gauges utilize all of the movement available from a tube to activate the movement of a gauge. In addition, we arrange the connecting link between tip and movement so as to lie directly in this same true path of motion, thus greatly simplifying calibration. Furthermore, tube life is increased because it is not required to move any farther than necessary to supply the required amount of motion for the pointer on the dial.

I find it impossible not to heed the clamor of the sales department to make a point at this time. That is, a gauge so designed and constructed will last longer, require less maintenance and be easier to recalibrate. All of this means that in the long run, a Lonergan gauge is the most satisfactory one to purchase.

Norman J. Smith

Chief Engineer, Instrument Division

Lonergan

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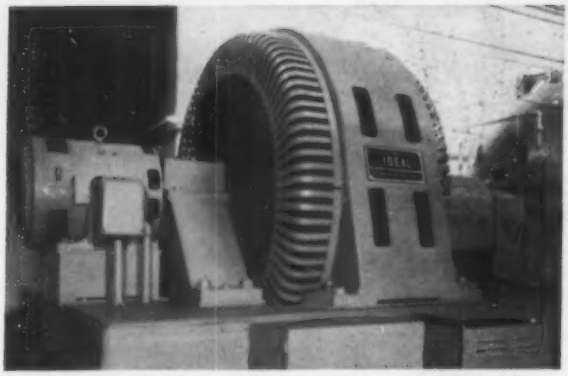

This 2750 H.P. Horizontal Synchronous Motor is one of 7 Ideal large synchronous units in operation at Detroit's new Springwells Station.

Three 400 H.P. Ideal Wound Rotor Induction Solid Shaft Vertical Motors in another area at Springwells Pumping Station.

the proof is in the PUMPING

Yes, whether installed in a chemical plant in Kentucky, in a sewage plant in Ohio, or on an irrigation project in Arizona, the proof of IDEAL Motor performance and economy is in the hundreds of successful pumping installations across the nation.

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MOTORS, GENERATORS AND CONTROLS TO 10,000 H.P.

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Controls each unit of radiation independently . . . provides heat only when temperature in immediate area falls below setting. Prevents overheating and fuel waste . . . corrects unbalanced systems. Self-contained . . . needs no external power supply or control . . . eliminates thermostats and zone valves. Installs like a radiator valve. Not recommended for 1 pipe steam systems.

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Condensation Pumps, Steam Traps, Heating Specialties

Leaders in temperature controls since 1916

Sterling inc.
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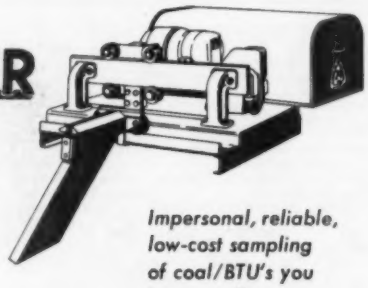


Impersonal, reliable, low-cost sampling of coal/BTU's you buy or sell.

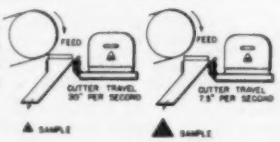
COMPLETE LINE OF SAMPLING AND SAMPLE PROCESSING EQUIPMENT

Wet, dry and dust-tight units. Simple, reliable, automatic. Units with cutter travel to 10' and longer. New bottom-dump dry cutters (patent pending) for use where headroom is 10."

Dimensioned layout drawings and specifications sent on request.

NEW... 30"/sec. Cutter Speed

reduces bulk of material taken — often eliminates cost of secondary sampling—without affecting reliability of sample.



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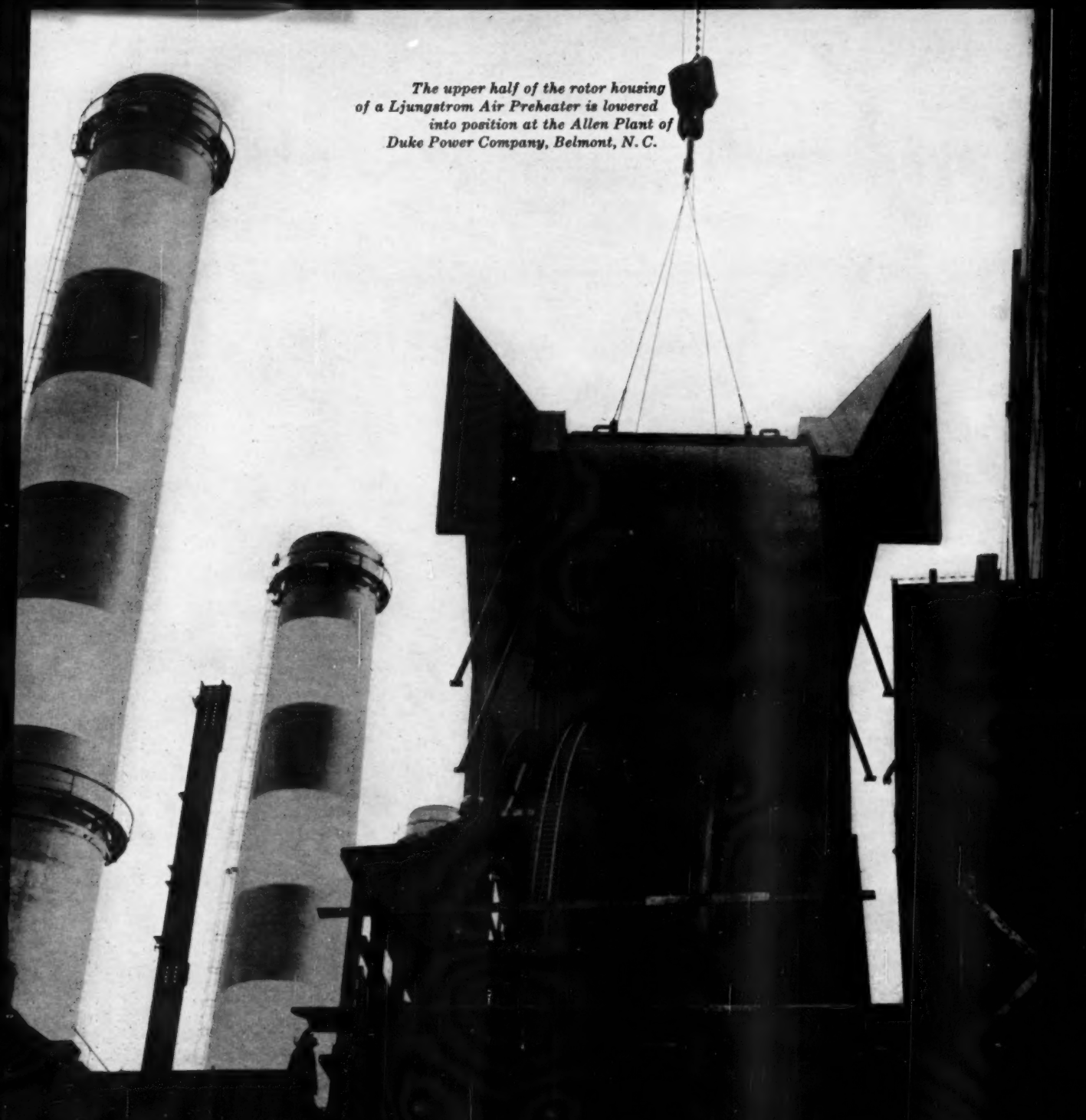

The upper half of the rotor housing of a Ljungstrom Air Preheater is lowered into position at the Allen Plant of Duke Power Company, Belmont, N. C.

IN NORTH CAROLINA...

DUKE POWER INSTALLS ITS 47th LJUNGSTROM®

Duke Power engineers expect 10% annual fuel cost savings with Ljungstrom Air Preheaters at Belmont. Two 512,000-lb Ljungstroms on the #5 boiler of the Allen Plant will preheat incoming air from 80°F to 575°F. Continuous rotary regeneration will recover approximately 390°F waste heat. Every 40° thus recovered cuts fuel requirements 1%.

Our engineers will be glad to recommend how Air Preheater equipment can improve your operating results on new or existing fuel fired units.

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THE AIR PREHEATER CORPORATION

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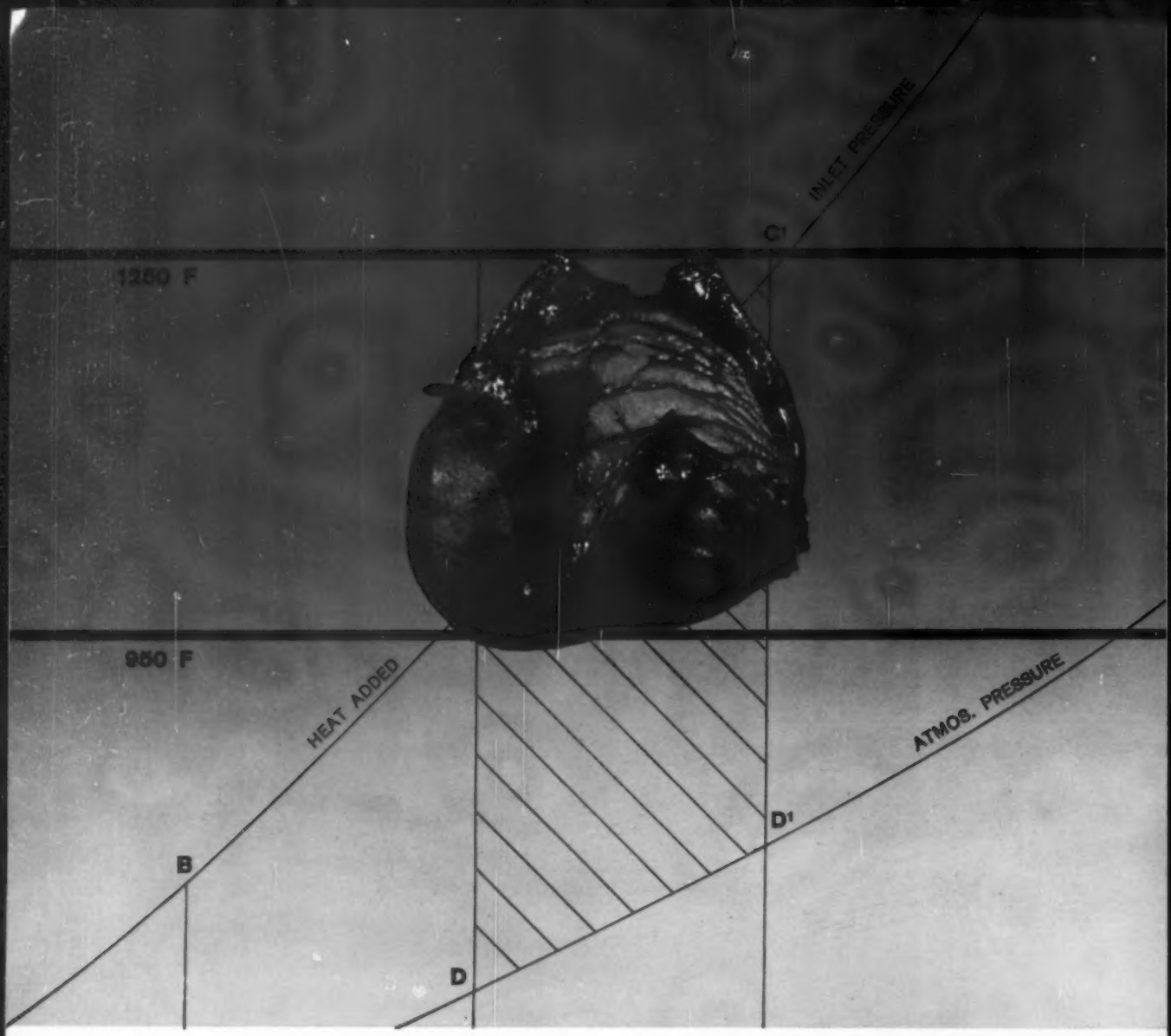

THE POWER RECOVERY "CHESTNUT"

or how to take power from 950F—1250F tail gas

A proven method for taking mechanical power from process tail gas below 950F is the turbine. Taking power from tail gas above this temperature has, in the past, been a power recovery "chestnut"—too hot to handle despite its desirability. But now, Worthington offers a Power Recovery turbine that can successfully pluck the meat from this very hot "chestnut."

The "meat" is extremely tasty. Frequently, if tail gas can be put to work at 1250F instead of 950F, as much as 12 to 15 per cent more power can be captured. In some installations, the heat exchangers that formerly handled the drop to 950F can be eliminated. In others, thermodynamic analysis will now show the feasibility of heating the gas to 1250F to get maximum mechanical power recovery.

In the past, use of Power Recovery turbines at the higher temperatures has been impractical. One major problem has been in mechanical design. Misalignment caused by excessive thermal expansion, higher temperature sealing, rotor construction, and forces imposed on the expander by inlet piping expansion and construction are all part of the problem. Today, Worthington has minimized them by creating a new design and using new materials.

A second major problem area that Worthington has overcome is analysis of the gas itself. Most tail gases are mixtures and their behavior is not fully plotted at the temperatures involved. But the behavior must be known before the turbine can be designed. Today, Worthington is ready to analyze the heat recovery potential of any gas or gas-steam mixture and to design a Power Recovery turbine to match.

If you would like to taste the meat of this power recovery chestnut, above or below 950F, write or call Worthington Corporation, Turbine Division, Dept. 48-14, Wellsville, N.Y.

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